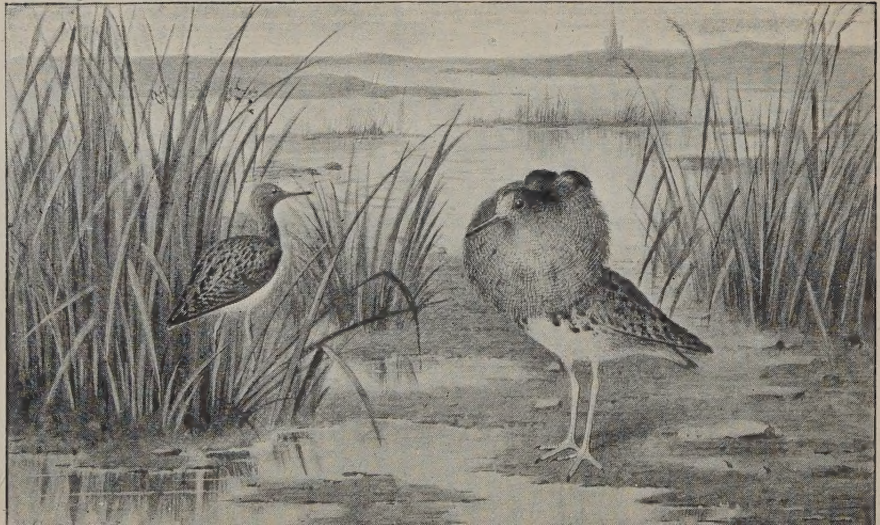

THE STORY OF BIRD-LIFE

By W. P. PYCRAFT

(1964)

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PREFACE.

To compress the "Story of Bird-Life" within the limits of the present little work has been no easy task.

The object aimed at has been to present the main features of bird-life in a general way. Hence it is hoped this volume may prove of interest to bird-lovers the world over, not because it contains information about the birds of any particular neighbourhood or country; but rather, because it serves as a guide to what should be looked for, and recorded, of the life-history of birds wherever they may be met with. Even dwellers in the sordid city have some material upon which they may exercise their powers of observation.

Since there are no less than 13,000 known species of birds, it would have been courting failure, and wearisome in the extreme, to deal with individuals in detail! The present work then is a skeleton picture, which each can fill up as he may for himself.

To those who wish to pursue this subject further, by the aid of other and more costly works, I would recommend the following as especially helpful:—

148755

The "Dictionary of Birds," by Prof. Newto
the "Elements of Ornithology," by Dr Miva
"Birds," by Mr A. H. Evans; (Cambridge Natu
History Series) The Royal Natural Histo
vols. III., IV.

These are a library in themselves, and sho
fill up whatever blanks the reader may disco
in the present work.

The excellent full-page blocks representing t
ruff, and bustard, and birds-of-paradise, ha
been drawn specially for this little book by
H. Grönvold.

W. P. PYCRAFT.

December 1899.

Pterylography by Nitzsch
Dr. Sadow's article on bird colouring
W. H. Hudson Birds of Argentina (Bittern)
Warde Fowler
Waterton
Capt. Bendire
Capt. Hutton
Headley
Gätke
Gerbe
Wray
Wallace's "Island Life" "Malay Archi
Gould
Sclater
Mutting
Chapman
Eagle Clarke
Walter Rothschild
Sperling
Canon Tristram
Mac Gillivray
Dr. Sharpe
Dolley

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THE STORY OF BIRD-LIFE.

CHAPTER I.

WHAT IS A BIRD?

WHAT is a bird? The text-books tell us that it is a warm-blooded, egg-laying, feathered biped, whose fore limbs take the form of wings, and whose jaws are encased in a horny sheath to form a beak.

Such a definition will suffice for most of us, but not for all. A few there be who would know more; who are curious concerning origins, and will not be satisfied by any such cut and dried definition; for a definition is not an explanation. To meet this curiosity in full is, however, beyond the scope of this little work.

As scraps by the wayside guide the pursuers in a paper chase, often through unknown country, so the fragments of rock, and bits of bone, left by time in the course of ages, serve to give us a clue as to the probable direction which our search must take. But here we have no clear view, only fragments of evidence which must be

laboriously fitted and pieced together, not on
but many times. We have to work in this, muc
as detectives work, and many of our "clues" a
about as useful!

From the evidence which we have collecte
so far, we gather that what we now know as
bird has reached its present form by a slo
process of change from some other, which wa
probably, more or less, like what we designat
to-day a reptile, *e.g.* lizard. We say more o
less, advisedly; for the lizard, in its turn, has a
equally mysterious origin. One reason then fo
thinking the bird in some way reptilian is becaus
it shares many things in common with this grou
things which occur nowhere else outside, thing
that are shared by both, probably by virtue o
descent from a common stock.

The bird has risen in the world so as to rank
by common consent of men of science—who fi
the part of Nature's Herald's Office—higher tha
the reptiles. These represent, to-day, its poo
relations.

This gradual change of form, from a more o
less like and uniform beginning, the ancestra
stock, and the division of this stock into tw
great classes reptiles and birds, we call evolution
Exactly how this evolution has come about eve
those best qualified to speak do not entirel
agree.

The hypothesis most generally in favour a
the present day is that of Darwin and Wallace
and known as "Natural Selection." Accordin
to this hypothesis the interaction of living organ
isms, one upon another, involves a "struggle fo

existence" in which the "fittest" survive, and the unfit are eliminated—the unfit representing those who cannot respond, or adapt themselves to changes in their surroundings or environment.

Although much abused, and generally misunderstood and misrepresented, this is nevertheless for the most part admitted to be the best and most satisfactory of any hypothesis yet offered us.

What answer will this give us to the question, How did the pigeons, ducks, geese, and songbirds, come to be?

Well, it would first of all draw our attention to the fact that "like begets like." That though the pigeon, the lizard and the snake all lay eggs, yet the pigeon's egg will never bring forth anything but another pigeon.

It will next point out the much less familiar fact that

> "No being on this earthly ball
> Is like another, all in all."

Now this is a most important observation. Just as all the children of a family differ one from another, so do all the birds of the same nest, though, perhaps, not so markedly to our eyes. Let us follow this up.

The children of this family intermarry with those of some other, and their children yet again with another, and so on. So that, if a census was taken of the population of, say a village, and careful measurements and observations taken as to the height, sight, and hearing, colour of the hair and eyes, freedom from disease, and so on, we

should find that half of the whole number wou fall below, and half would rise above a commo mean. The mean, of course, would be differen for each test. Thus a large number of tho who were included as above the average height might find themselves bracketed as belo the average in power of endurance, and so on.

In this tendency to vary we have the ra material used in Nature's workshop in the man facture of new types.

Man long ago seized upon this fact and turne it to his own advantage, as witness our garde flowers and vegetables, and our domestic cattl These have only reached their present form b slow degrees, each stage improving upon the las The result of such a series of progressive change must be to remove slowly from, and obliterat in, the individuals concerned, the traces of the ancestral likeness.

In the case of domestic animals we can co stantly compare the latest variety with th original stock from which it was derived. Fo instance, all the domestic pigeons are descende from our common rock dove. Selective breed ing—that is to say, breeding with a definite en in view—has resulted in numerous varieties s unlike one another, and the original, that di they exist in a wild state, we should regard eac as a separate "species." When it was desired for instance, to obtain birds with enormous flesh lobes or wattles round the beak and eyes, thos young, in which this feature was most develope were selected to breed from, the rest went t supply the table. The offspring of the selecte

were similarly treated, in this way the character grew more and more marked till the present somewhat unsightly forms came in to being. The experience of many of my readers will supply a dozen such instances.

A similar process of selective breeding seems to be going on around us, amongst wild animals and wild plants. It has given us hare and rabbit, wolf and fox, lion and tiger, and so on. These are all different from what they once were; they are all modifications of some earlier form. More detailed explanations of these things must be sought in other and more learned treatises; they have no place here.

This development of species and races leads us to consider another very important factor in the making of a bird. This we call specialisation.

We find certain birds fitted apparently to live only upon certain spots on the earth's surface or upon certain food. We say these are highly *specialised.*

The little humming-birds afford us an admirable illustration of a specialised bird. They feed by hovering on the wing, under flowers, and thrusting up the beak into the long tubes to get at the insects and honey. For this purpose, the beak and tongue are of great length, often exceeding the length of the body of the bird itself. The tongue differs from that of all other birds, and is tube-like in form. Now the young birds, when just hatched, have tiny three-cornered beaks like those of a swift. We gather from this —those of us who study these things—that this long beak is a new kind of beak and that, once

on a time, it was like that of a swift. This gives us an inkling. We turn to the swifts and comparing their anatomy generally, with that of the humming-birds, we find some extraordinary resemblances. So much so that we feel justified in regarding the humming-birds as having got their characters from the same source; in other words, we conclude that the humming-bird and the swift are closely allied, and regard the former as a highly "specialised" form of the latter.

We shall often have to refer to specialisation in these pages, and we shall take up again this question of descent.

Specialisation may be carried to such a degree of perfection that any considerable change in the environment of an animal may cause its extinction. The sabre-toothed tiger, the moa, great auk, and dodo, are illustrations of this. Let us take another from ourselves. The labourer corresponds to what we call a generalised type. He can earn his living in many ways; the watchmaker, or woodcarver, or artist, only in one. If the latter are prevented from carrying on their trade, starvation and death stare them in the face—they are too specialised to turn to some new mode of earning a livelihood.

Briefly then, the creature which we know to-day as a "bird" is probably the specialised product of some reptilian form of ancestor, the particular direction of this specialisation being that of flight.

Moreover, the bird differs from all other creatures that fly in the method whereby this power of flight is brought about. Apart from

the *skeleton* of the wing, which will be considered later, there is an equally unique difference in the nature of the flying membranes which this skeleton supports. In bats, the only real flying members of the class mammalia, this membrane takes the form of a thin web of skin, stretched between the fingers, and running down the arm and side of the body; in certain so-called flying-squirrels this membrane is much smaller in area and does not extend between the fingers; the result is a form of parachute. In birds, the membrane plays a quite secondary part; instead, certain of the feathers clothing the hinder margin of the wing become enormously elongated and flattened out. These, by aid of strong ligaments at their base, and a peculiar method of over-lapping one another, form a broad surface which proves even more efficient for its work than does the skin folds of the bat. The bat's wing would resemble the bird's, if certain of the hairs along its hinder margin became elongated and flattened out so as to take the place of the membrane now existent. A reference to the figures should make this clear. Fig. 6, p. 227.

The sum of the whole of this process of evolution is a form specially adapted for rapid progression through the air. The leading characteristics of this form may be summed up in the long slender and mobile neck and pointed head, the perfectly rounded and somewhat elongated body of extreme lightness, raised and propelled by wings, and clothed in the lightest and strongest possible

materials, which we call feathers—such is
bird.

All of us know that a bird is clothed wi
feathers, but probably few know anything of t
peculiar manner in which these are distribut
over the body, or have ever taken the troul
to find this out; we content ourselves—if
ever trouble to think about it at all—wi
reasoning from analogy and the deductio
drawn therefrom. The hairs of the silky co
of a well-groomed horse, or of a dog or c
we remark, are set as close as close can be, o
to another all over the body as are the ha
in our head. Surely therefore, we assume, t
feathers would be similarly distributed.

Now, this is exactly what does not happe
One of the earliest to point this out was a Germ
ornithologist named Nitzsch. Just upon six
years ago he published a wonderful book
this very subject, in which he showed th
although the whole of the bird's body save
beak and "legs" are concealed from view
the feathers, yet these need by no means occu
a very large area of the bird's skin. On t
contrary, he found that they are always mo
or less restricted to certain definite areas, whi
he called "feather-forests" separated by tra
of skin, often perfectly naked. On this d
covery he based a series of most important a
far-reaching observations, which eventually, aft
his death, were published, and now form t
foundation of what might almost be called t
"science" of Pterylography. Perhaps we oug
to regard his work as something more than

foundation, for comparatively little has been added since his death. But this by the way. The study of Pterylography tells us then, not only that the feathers are restricted to certain areas of the bird's skin, but that the size and form of these areas vary. Thus we may have one strongly defined tract running down the backbone from the nape of the neck to the tail; this is called the spinal tract. Another runs from the throat down the front of the neck and dividing at its base, passes down on each side of the breast and abdomen to the inner side of the thighs quite to the end of the body; this is called the ventral tract. Then we have a pair of tracts running across the upper arm, these are the humeral tracts;—the feathers forming these tracts are known to the field ornithologist as the "Scapulars"—; and a pair of tracts over the thighs; these are the femoral tracts. Besides these we have the feathers covering the wings, the head, and the tail which are generally dealt with separately in special treatises, and called each by a special name. The form of these tracts is so constant that experts can tell at once to what group any particular bird belongs, and often even to what species.

A little reflection will carry us a step further, and suggest to us that, if the feathers are restricted in their distribution they must, to conceal the skin, be (1) very long and broad, and (2) directed so as to slope away from a line drawn through the middle of any given tract. And this actually obtains.

The reason for the existence of these tracts not so obvious. It has been suggested that th represent the regions of the body where resistan during flight is least. That is to say, their striction to certain areas, gives greater freed of movement to the limbs. But this is not very convincing explanation. Possibly we shou be nearer the truth to regard it as an instan —one of many—of the economy of material often practised by Dame Nature.

The number of feathers, or rather the size the tracts bears some sort of relation (*a*) to t amount of specialisation which the bird has und gone generally; and (*b*) to the particular mo of life which the bird follows. Thus, the m highly specialised of all birds—the passeres, which a crow may stand as the type, are the m scantily clothed of birds, the tracts being ve narrow, and the spaces very wide, whereas t birds of the ostrich kind have the feather tra of great breadth, so much so, as to make it di cult to find the spaces.

So far, the feathers of which we have be speaking have been those known as the contou feathers; because, as their name implies, th form the contour or outline of the body. In ma birds, as a duck, for instance, if we raise t contour-feathers, we find below a thick und clothing of down-feathers. These will need lengthy description. They are familiar to a either in the shape of eider-down or swan's-dow They are found to be closely interspersed among the bases of the contour-feathers, and over t spaces, so as to form a thick underclothing.

A very remarkable form of down-feathers is found in many birds, such as the common heron, the bittern, some hawks, parrots and tinamous. This is known as "Powder-down." The exact nature of this powder-down is not yet thoroughly understood. It is peculiar, in that it is constantly crumbling away into an exceedingly fine dust, which feels something like Fuller's Earth when rubbed between the fingers. In the herons, it grows from enormous patches on the body—a pair on the breast, and a pair over the thighs. These, when the bird is skinned, appear on the inner surface of the skin as large dark-coloured areas.

Filo-plumes would hardly be recognised as feathers at first sight. Exactly what is meant by a filo-plume can be seen at a glance by a visit to the kitchen, or the nearest poulterer's when a newly plucked fowl is undergoing preparation for its appearance later on in the dining-room. You will notice that, now that the feathers have been removed, the body appears to be sparsely covered with long delicate hairs. These are the filo-plumes. Their true feathery nature can only be fully made out by an examination under the microscope, before they have quite completed their growth.

Sometimes the filo-plumes attain great length, and are then quite conspicuous. In the cormorant, for instance, they form a large white patch on each side of the body during the nesting season of the year.

Another, and very greatly modified kind of feather occurs in the form of eyelashes, and what

are known as rictal bristles. These last are
long and coarse, or rather stiff hair-like structu
which grow around the mouth of goat-sucl
and fly-catchers, for instance. Eyelashes oc
in many birds, such as hornbills and ostriches

But we have not yet exhausted the list wh
must be examined before we can say that
know how a bird is clothed. Since in
majority of birds we find the legs, or to be q
correct, the *feet*, are encased in a covering
scales or scutes, of various forms, whilst the
of the toes, and of the thumb and first fin
at least are ensheathed in horny claws, wh
are sometimes of great length and streng
The beak, too, is encased in horn, but we sh
have something further to say about this late

The scaly covering of the "legs" and t
may be replaced by more or less extensive ar
of smooth skin, or by a partial or complete
vestment of feathers, which may grow, as in sc
grouse even on the soles of the feet, like the
on the sole of the rabbit's foot.

There are few objects with which we are m
familiar perhaps than feathers. They en
largely into the comfort of our everyday l
they figure conspicuously in our personal a
household decorations, they add splendour
our pageants, form the crest of the h
apparent to the throne, head-dresses for
army, and constitute not seldom our standa
of comparison for beauty and lightness; y
there are few things probably about which
know less. Let us learn!

To begin with, a feather is an absolut

unique structure, it never has been, nor is now, grown by any creature under heaven other than a bird, just as hairs, for instance, are found only within the class mammalia—animals that suckle their young. But the bird's covering is more peculiarly exclusive, since no bird is clothed, in any way other than with feathers, whereas mammals, or more popularly "animals" may have the skin covered with scales, as in the manis, or horny plates, as in the armadillo, or curious modifications of hairs in the shape of spines, as in the porcupine, or wool as in the sheep, or bristles as in the pig, or may even be entirely naked, as in the whales and porpoises.

What is a feather? Feathers are to the bird what scales are to the fish and reptile, and hairs to the mammal—a covering to protect the surface of the body, and to regulate its temperature. We cannot tell much about their structure without a microscope. We have seen already that there are different kinds of feathers. There are those outside that form the general contour of the body, some of which grow very large to form the "quills" with which the bird flies, and from which our pens and toothpicks are made, and there are those below the surface, the chief of which we call down, eider and swan's-down being familiar to most.

We can learn something about them however without a microscope. A "quill" feather will serve us best. Take one, and note first of all the strong central axis or shaft; along each side of this you will see hundreds of little straight branches set very close together, and held in

position, as you will discover, in some mysteric way, so that the branches, as a whole, combine form what is called a "web." If you try to p this "web" apart in any place, you will see th it gives way reluctantly. Hold it up to the lig and you will get an inkling of the reason of th Along each of the little branches you will fi other little branches, arranged, much as were t larger branches on the main axis. The larg branches are called barbs, the smaller barbul Now all the barbules turned towards the base the feather, have their top edges inturned, whi all the barbules turned towards the tip of t feather bear long and delicate little hookle These overlap the inturned edges of the hind set, and the hooklets seize upon them and ho in like so many grappling-irons; thus you s how the web is formed. Now for some figur On a piece of the web of about 15 in. lo of a crane's quill feather there were count no less than 650 of these barbs, each of whi bore about 600 pairs of barbules—that is abo 800,000 for the inner web alone, and more th a million for the whole feather! The accura of these figures can scarcely be doubted, f they are the result of a careful examinati into the matter by Dr Gadow, one of o greatest authorities on bird anatomy.

The peculiar curling qualities of the ostri feather are due to the fact that the feather is a degenerate structure and has no hooklets, co sequently it has lost the faculty of formi a "web." Hence the barbs are permanent disconnected.

Once a year at least every bird dons a new suit. This is done by a process known as moulting, during which the old feathers are cast off and replaced by new ones. In the lizards and snakes the external layer of the skin is thrown off more or less whole, much as is the shell of the lobster or crab, but in the bird it is done much more gradually. The feathers are cast separately, their places being immediately filled by new ones. These are at first enclosed in a thin blue sheath which breaks away in flakes near the tip, and slowly exposes the gradually unfolding feather within. Sometimes this sheath remains whole for a very considerable time, and thus gives the bird the appearance of having spines mixed up with its plumage.

As a rule the moult begins at the end of the breeding season so that the old dress, worn with the work entailed in rearing a family, may be discarded and gradually replaced. Some moulting however takes place, in the case of certain male birds, before the period of courtship begins. At this time they assume the purely decorative part of their plumage, and throw it off again after the serious business of life is over.

Swans, geese and ducks, moult all the quills at once, so that for a time they are flightless. During this time they remain in the strictest seclusion, sometimes even throwing off their characteristic male attire to don the more sombre garb of the female, and thus to render themselves less conspicuous. In the case of certain ducks, when both male and female, and young,

are more or less brilliantly and conspicuous
coloured, no such change of dress is possibl
Having so definitely "assumed the purple" ar
renounced the plainer garb, it is impossible
revert. As a rule, the quills are moulted
pairs, thus, even when moulting, escape by flig
is possible.

Some birds there are who carry the process
moulting much further, and even periodicall
shed their claws as in certain grouse, or th
sheath of the bill as in our common Englis
puffin. Concerning the colours and coloratio
of feathers—for these are not the same—ther
is much to be said, but most of it is of to
technical a character to be dealt with here.

Strange as it may seem it is yet true that th
colour which a feather appears to be is ofte
quite other than that which it *is*, at least th
chances are one to three of its being so. Th
colours of feathers are classed under three heads
Under the first of these come, what are know
as chemical or absorption colours. These are du
to pigment, or colouring matter, either evenl
distributed or diffused through the substance o
the feather, or to little particles of colourin
matter packed closely in between its fibres,
we may so term what would be scientificall
known as the cells of the tissue, which combine
form the feather itself. Such colouring matter
not affected by changes of the position of th
light by which it is illuminated. Thus, re
yellow, brown and black feathers always remai
the same. Orange and yellow generally, gree
rarely, blue never, belong to this category.

Of these colours that which is known as turacin is the most remarkable. It is found in the red feathers of the turacou or plantain-eater of Africa. In addition to the colouring matter, these feathers contain from 5 to 8% of copper, which can be extracted, Mr Church tells us, by soaking in a little weak ammonia and acetic acid, and filtered off as a metallic red or blue powder. These birds lose the red colour when washed by the rain, but regain it when dry, moreover, this colour is said to tint the water in which they bathe, just as is said to be the case with the common heron.

The second kind of colouring is that produced by the combination of pigment or colouring matter, and certain structural peculiarities in the surface of the feather itself. Violet, blue and green, are colours produced in this way. Thus the deep blue feather of a parrot held against the light no longer appears blue, but grey or yellowish. The green feathers of the Amazon parrot, when wetted, appear brown. Blue colouring matter has never yet been found in birds. The blue colour of certain feathers is due solely to structural characters. The only colouring matter discoverable is either brown, black or orange, according to the particular tone of the blue.

To the third form of colouring belong the exquisitely beautiful metallic tones, such as occur in the common English starling, the humming-birds, many pheasants, the "tail" of the peacock, birds of paradise, and so on. These are all due to the structure of the sur-

face of certain parts of the feather whic
through the microscope are seen to be strange
and wonderfully carved into fine ridges a
grooves, or covered with tiny dot-like papilla
these act like so many prisms, and hence th
marvellous play of colour which so fascinates u
Those who would like to know more of th
subject should read Dr Gadow's lucid descri
tions in the new "Dictionary of Birds," a boo
all bird-lovers should possess.

The beak sheath, to which we have already r
ferred, constitutes the outer covering of the jaw
which form what is commonly known as th
"bill" or "beak" of the bird. Sometimes th
sheath, as in the petrels, is made up of a numb
of pieces; sometimes, and more generally,
consists of two simple cases only, one for t
upper and one for the lower jaws. The vario
forms which the beak assumes are to be dea
with in our next chapter.

The claws are the "nails" of the bird's fo
and vary in form, length and so on accordi
to the need of the bird. In many birds, such
the heron, and night-jar, and some others t
claw of the middle toe bears a curious litt
comb the purpose of which no one has yet be
able to discover.

Many birds are armed with formidable spu
Sometimes these grow on the legs and sometim
on the wings. The screamer, a South Americ
bird, allied to the ducks and geese, has a mo
formidable spur on its wrist joint. The comm
barn-door fowl bears spurs upon its legs. In t
olden time, when cock-fighting was a favouri

amusement, the length and offensiveness of these spurs was increased by the addition of long silver sheaths which were fastened on to the real spurs. The use of spurs to wild birds, whether on the wings or legs, is the same—for purposes of offence. The males, by whom they are almost exclusively borne, fight furiously with these, for the possession of such eligible females as may be in the neighbourhood. As the strongest almost invariably wins he hands on his more vigorous constitution and better weapons to his offspring and these again repeat the process, thus in course of time the size of these spurs has increased to the size we know them now.

CHAPTER II.

BIRD LIVERIES AND THEIR MEANING.

We have now completed a very brief survey of how a bird is clothed, at least from the point of view of the *way* in which this clothing is worn, so to speak. I propose now to carry my readers with me through a rapid survey into the domain of bird fashions, to try and contrast the sombre and the splendid, the useful and the ornamental. But we can do no more than peep.

The gorgeous plumes of the bird of paradise, the splendid "train" of the peacock, the brilliant hues of the humming-bird, the garish colours of the toucan or the macaw, have at times excited the wonder or the admiration of us all, but, few perhaps suspect the fascinating problems to

which these have given rise. What is *exactly* the meaning and interpretation thereof we do not as yet know; we feel, as yet, in the twilight. Certain rules or laws have been formulated which are generally admitted as satisfactory, and possibly the true explanation. But an analysis of these is outside the scope of the present work. We will sample the fruits resulting from the patient and laborious research of students of all nations in this field, foremost amongst whom stands our own countryman Charles Darwin.

Briefly then it is, I take it, a matter of common knowledge that when the colouration of the sexes of any given species differs the male birds are more brilliantly coloured than the females. The reason for this, we are told, is that if the female were as conspicuously coloured as the male she would be easily discoverable when sitting on her eggs by prowling enemies; a more sombre dress enhances the safety of both mother and offspring —a very important consideration if the species is to hold its own in the struggle for existence. Now, we have some really weighty evidence in favour of the truth of these interpretations, since it sometimes happens that the case is exactly reversed, and the female dons the gayer dress. Whenever this occurs it always happens that it is the *male* which undertakes the incubation of the eggs. The little phalarope, one of our British birds, affords us a case in point, as also do the little three-toed bustard quails of India, Africa, and Australia, and the painted snipes of India, Africa, Australia, and S. America. Darwin's explanation of why the

males are more beautifully coloured than the females, or rather, of how the males have acquired their superior beauty we shall consider in a later chapter.

We mentioned just now, that the plumage of the females was often of a sombre hue when that of the males was of a brilliant colouration : and remarked that this was for protective purposes. In the cases in point, however, this need for protection was only partial and requisite only during the breeding season. In some cases, however, as of desert-dwelling species the tone of colouration both of males and females is that of the surrounding country. Shelter being difficult, the birds are consequently always exposed to attack, and hence both sexes have come to assume a tint precisely similar to that of the sand and rocks by which they are at all times surrounded. From this fact they can more easily escape observation from their enemies. Desert wheat-ears, sand-grouse, and coursers, are the best known examples of this kind of protective colouration as it is called.

Sometimes we have a seasonal protective colouration. The British ptarmigan affords us a splendid illustration of this kind. In the summer and autumn both male and female are clothed in a dark plumage, a mixture of dark brown, black, buff and grey—according to the sex and time of the year. In winter, both don a white dress, so as, apparently, to harmonise with the snow-clad hills amongst which they roam, again to render themselves less conspicuous and so to escape from their ever present enemies

—which it must be mentioned, are in their turn obliged to adopt a similar change that they may creep up unawares. Thus under the spur of hunger is the evolution of the species involved in this competition, furthered; by means of this system of interaction one upon another, does each become more and more specialised, and at the same time nearer and nearer the day of its extinction, which must arrive so soon as one of the two competitors fails to respond to further stimuli. We have a similar object lesson in evolution enacted before us in the growth of modern warfare. Compare the modern battleship with the old three-decker. The iron vessel which may be likened to the defenceless prey was the outgrowth of a need to resist more powerful guns—the type of the prowling carnivore—and ships and guns have been competing for the supremacy ever since, and the end is not yet.

Some birds, however, adopt protective colouration which is not seasonal, but permanent. Strange as it may seem, some of these are amongst what would appear to be, the most conspicuously coloured of birds. Take the case of the hoopoe. This is an occasional visitor to Britain—and would probably become resident were it not so ruthlessly shot down on its every appearance in this country. It is of a rich buff, or sand colour, with a very large and beautiful crest on the crown of the head, and the wings conspicuously barred with black and white. Yet, on the approach of a hawk or other enemy, it throws itself flat on the ground, drops its crest, and spreads out its wings and

—heigho, as if in obedience to the magician's wand our bird has vanished; what appears to be a bundle of rags remains in its place.

The colouration of some of the most sombre plumaged birds we are apt to regard as instances of the "dull but useful" order: and to reflect, with the eye of a careful house-wife, on its good wearing properties: and here we generally leave it. As a matter of fact, it is fraught with a deep significance. It certainly affords us some admirable illustrations of protective colouration. Take the case of the night-jar or goatsucker, the bird which shares with the bat and the owl, the charming twilight evening hours of our rural England. Its exquisitely mottled plumage of grey and brown so perfectly harmonises with the bough *along*, and not *across* which it rests, or when sitting on its eggs, with bits of bark and stone strewn about the ground, that it becomes invisible, and can only be detected by the merest accident. Again, in the "common" bittern of our Islands—alas! no longer common—we have a splendid instance of protective colouration, aided, as in other cases, by posturing on the part of the bird. The general tone of its plumage is buff, streaked with black in such a way as to simulate the colour of the dried stems of the reed-beds which it frequents, and the shadows between the stalks. On alarm, the bird straightens itself out so that the head, neck and spine form one vertical line, pointing skywards. Thus posed, it remains absolutely still till danger is past: the chances of detection amid such surroundings being infinitely remote. How

difficult this disguise is to detect, has been tol of the little bittern of Argentina, by Mr Hudson as only Mr Hudson can tell it. The story is to long to be reproduced here, but my readers ma turn with profit to the original.

We have yet another kind of protective colour tion which is truly remarkable. It is of th kind known as "mimicry." In cases of "mim cry" the bird does not resemble surroundin inanimate objects, but some other bird, and tha bird either one that is much feared and dreaded or regarded with indifference. It is not only case of the wolf in sheep's clothing, but also c the sheep in the wolf's. The latter case, indeed is a realisation of the ass in the lion's skin.

Let us take a few examples. In Centra America there lives a bird of prey known as th caracara or curassow hawk, which so closely re sembles a curassow, one of the game-birds of tha region, as to deceive experienced sportsmen who shoot the bird for the purpose of providin food, only to find it a carrion-eater. This re semblance is of a distinct advantage to the hawk He is enabled thereby to capture his prey wit ease, since the victim, mistaking its enemy fo the guileless game-bird, allows the approach c the hawk to within easy striking distance, with out entertaining a suspicion of danger so close a hand.

The hawk-cuckoos of India and Africa affor us an illustration of the opposite form of mim cry. These birds very closely resemble th sparrow-hawks of the locality; similarly, ou English cuckoo resembles our native sparrow

hawk. In such cases again the advantage gained is quite apparent. Wherever the cuckoos go they are mobbed more or less violently by all the smaller birds in the neighbourhood in mistake for their hereditary enemy the hawk; the tribe has an evil name in the bird world, and not without some reason. Now, as we shall show later, the cuckoo is a parasitic bird, inasmuch as it leaves its offspring to the care of strangers. To do this, the egg must be deposited in the nest of strangers, a rather difficult task when both of the intended foster parents are busy near the nest. The male cuckoo, therefore, seeks to drive, or draw them from home, by hovering near the nest hawk-fashion, and at last inducing both parents to leave home in an endeavour to chase the intruder away. By the time they have returned, the fell purpose has been effected, the female having slipped at once to the nest, and deposited her egg therein, to be hatched by the unsuspecting dupes. The black cuckoo of India is an even more wonderful instance of mimicry. It has come to resemble the black drongo—a kind of shrike—of the same locality so perfectly as to make it difficult at first sight to distinguish the two. The most curious part is, that the drongo-shrike resents fiercely the approach of any intruder near its nest, and yet it is *in* this nest that the cuckoo lays its egg, and it is by the shrikes that the young cuckoo is reared. The resemblance of the cuckoo to the shrike is so close that the latter are quite deceived, and mistake the cuckoo, when seen near the nest,

either for one of its own species, or for its ov
mate. This ability to successfully mimic t
shrike has certainly proved of the greatest val
to the species.

In the earlier part of this chapter we spoke
the resemblance of certain birds to their norm
surroundings. This is called "adaptation
environment." Concerning this we have a f
more words to say.

A little reflection will call to the reade
mind the fact that most animals, *e.g.*: fox
hares, rabbits, most birds, reptiles and fi
are of a darker colour above than below. T
great advantage of this has recently been m
successfully demonstrated at the British Muse
(Natural History), by means of a couple
models prepared by Mr Thayer, of the Unit
States of America. It was done in this wi
A large square box was lined with grey flann
and in it were placed two bird models wh
were fastened to a rod running through t
middle of the box. Both of these dumm
were covered with flannel cut from the sa
material as that used to line the box. O
however, was painted dark above and wh
below, the other was left uncoloured. Stran
to say, the uncoloured bird is most conspicuo
the painted bird, by counteracting the norm
light and shade, becomes, at two yards' distan
almost absolutely invisible.

Thus, then, we must altogether cease to
gard the colours of animals as due to mere chan
Whether gorgeous or plain, brilliant or d
there is a meaning behind it. Of the truth

this we shall have still more evidence in the course of these pages.

Sometimes, in addition to resplendent colours, we get wonderful developments of the feathers themselves. We have not space to do more than make the slightest references to such here, and to give one or two illustrations thereof.

In the Birds of Paradise alone we get some most marvellous illustrations of this, such as the superb Bird of Paradise and King of Saxony's Bird of Paradise. This last has been quite recently discovered. The long streamers from the head are horny in texture and like nothing else in the bird world. What these are like can be gathered from the accompanying pictures (fig. 1).

Let us here pause to consider some general rules which appear to govern the colouration of the plumage from infancy to adult life. To be brief, when the male plumage is conspicuously brighter than that of the female, the young in their first plumage after moulting the nestling down resemble the female. The females retain this form permanently; the young males after a longer or shorter period assume the characteristic male livery.

When the male and female are both alike and more or less brilliantly coloured, the young don a livery different from both, as is the case in the robin and starling; or the young may closely resemble both parents and lack only something of their brilliancy, as happens with the kingfishers, for instance.

The time which it takes for a bird to gain

Fig 1.
The King of Saxony's Bird of Paradise (upper figure).
The Superb Bird of Paradise (lower figure).

the adult plumage varies from a few weeks to about three years or more. Those of my readers who reside in England can watch this process, through a most beautiful series of transitions, in the common starling: the whole process takes in this case but a week or two.

Changes of colour in plumage may be brought about either by replacing old feathers by new, or by wearing away of certain parts of an adult feather. There is yet a third way, according to some, and this is by an actual deposit of pigment in the feathers in position at the time the required change is made.

Sometimes colour-changes can be induced artificially, as witness cayenne-fed canaries and birds fed on hempseed. Bulfinches and other birds turn black on a diet of hempseed. The natives of the Amazonian region feed the common green parrot, says Darwin, with the fat of large siluroid fishes, and the birds thus treated become beautifully variegated with red and yellow feathers. In the Malay Archipelago the natives of Gilolo alter, in an analogous manner, the colours of another parrot; so great is the resultant change that the bird has been, after the change, described as a new species.

Mr Alfred Wallace records an even more remarkable fact. The native South Americans have a curious way of changing the coloration of the plumage of parrots and certain other birds. This they do by plucking out the feathers from the part to be operated upon, and inoculate the fresh wound with the milky secretion of a small toad. The feathers then grow of

a brilliant yellow colour, and on being plucke
out, it is said, grow again of the same colou
without any fresh inoculation.

It rarely happens that a bird having onc
donned a smart livery ever discards it for
dull one, yet this happens in the case of the wil
duck. In the summer of every year he, a
it has been described, "goes into eclipse" an
assumes a plumage so like that of his mate a
to be almost indistinguishable. As at this tim
of the year he has for the nonce lost his powe
of flight, it is probable that this sombre dress
a source of safety. In the autumn he re-assum
the splendid dress in which we know him.

As a rule, whatever bright colours or orn
ments are developed follow late in life. The
are one or two exceptions to this rule. Th
nestling Gouldian weaver finch of Australia f
instance has at the angle of the mouth thr
small bead-like bodies of a brilliant opalesce
emerald green and blue; the roof of the mou
itself is marked by five black spots perfect
symmetrically disposed. As the bird is qui
blind at this time it is difficult to see wh
can be the reason or use of such ornament
The nestling of the red-tailed weaver finch
Samoa again has a red wattle at the ga
which disappears in the adult; and many
our British birds have yellow-gape-wattles.

The curiously striped nestling of the gre
crested grebe bears a heart-shaped, fleshy e
crescence of a brilliant coral-red colour on t
crown of the head. No trace of this is fou
in the adult. The nestling of the coot has t

head ornamented with curious tiny red wart-like bodies of a bright red colour, but these disappear as soon as the nestling period passes away. We fear that the explanation of these things is yet a long way off.

It is possible, of course, that they may be remnants of structures once more perfectly or extensively developed: they may be the last remaining record of a style of decoration now obsolete. Just as the young lion bears upon his coat distinct spots and stripes indicating his origin from a striped ancestor.

CHAPTER III.

HOW A BIRD FEEDS.

We may admit it grudgingly, we may never have realised it as a fact, but is nevertheless true that hunger, the imperative command to eat, has played a most powerful part in the drama of our evolution. Not less severe has been the struggle for daily bread on the part of every other living thing. The result of all this is writ large in Nature's records, and the beasts of the field, and the birds of the air, past and present, are so many witnesses, eloquently silent, testifying to the truth of this.

Let us now confine ourselves to birds, and see how this is borne out.

It is obvious that a given area of land will support a larger number of creatures of different habits, and requiring different food than would

be the case if all required the same kind of food
One eats what another leaves. A verification o
the old adage "what is one man's meat is anothe
man's poison." The outcome of this effort a
adaptation to different localities, the struggle t
hold unoccupied corners, is seen in the differen
modification of organs and forms of the body i
the various animals and plants around us. I
the case of birds we have numerous examples
We have birds that have become specially mod
fied, so that they are enabled to seek their foo
beneath the surface of the waters, birds tha
obtain their food in mid-air, birds that delv
beneath the ground, birds that tax our fields an
orchards, birds that eat other birds, and a doze
intermediate stages of feeding and procurin
food: some of which we shall discuss presently.

When we want to find out how an unknow
animal feeds we look first of all at its mouth
The entrance to a bird's mouth is its beak. Thi
is a part of the head which is produced forwards
more or less into a point. This point is divisibl
into two parts or jaws, an upper and a lower
both of which are encased in a horny sheath o
more or less density. On the form and texture
of this sheath much depends. Moreover, w
shall soon see that it is not the beak that make
the bird, for we have beaks of similar form
belonging to birds not at all related—the like
ness has been brought about by the simila
mode of feeding. At one time the shape o
the beak was considered a very importan
character by which to judge of a bird's relation
ship. It was treated somewhat after the fashio

of armorial bearings, and a bird's pedigree was "read off" and its rank assigned according to the form of its beak.

The model of the strong, sharp-pointed, hooked beak of the birds of prey is closely followed by that of the parrots. In both cases we have an adaptation to the peculiar requirements of each group. In both it is needed for tearing up large portions of food into small pieces, albeit one is of flesh and another fruit. The parrot's beak, however, has proved itself readily convertible into the hawk's, inasmuch as a New Zealand parrot has, within recent years, changed its diet very largely from one of fruit to that of flesh. Since the introduction of sheep into that part of the world by the settlers, this bird seems to have found a diet of flesh more stimulating than one of fruit. Exactly how this came to be is not known. Two explanations have been advanced. The first has it that the birds settled on the skins of the sheep slaughtered for their wool, and picked off pieces of fat therefrom, as well as various tit-bits from the carcasses of the same, and thus found out how toothsome — or beaksome — mutton was. From this they went a step further and did the slaughtering for themselves. Parties of them now go a-hunting, worry a sheep till exhausted, then dig down through the back and so wound the intestines that death results. Another explanation is that the birds in the original instance mistook the sheeps' backs for the huge masses of lichen common to this region, and of which the birds are very fond. Not finding it to their taste at the top, they dug deep and soon came to the flesh

which, like the forbidden fruit, proved more pa
table than that which was provided for them b
bountiful Nature. The result is, they have
come a menace to sheep farmers, and are, on t
account, in danger of extinction. It has, ho
ever, been denied recently that the dama
inflicted is anything like so serious as th
and the latest evidence to hand has do
much to clear the kea's character. Kea is
name bestowed by the Maories on this bi
Specimens of the kea, provided with mutt
chops, can be seen at the Zoological Gardens
London every day.

The stork and plover tribe and the hummi
birds furnish us with some admirable illustrati
of the outcome of a gradual modification to s
the demands of a peculiar diet; and give to th
possessors an advantage over their neighbou
a sort of monopoly over certain kinds of food.

In the avocet a nearly extinct British bird
the plover kind the beak is awl-shaped, be
turned upwards, and produced into a point
extreme thinness. With this the bird is enab
to feed on minute aquatic animals, otherwise
possible of capture. The wry-bill plover
the bill turned sharply to one side, enabling
bird to pick out small crustacea, and the li
from under stones. The scissor-bill, a kind
tern found in the tropics has the upper and lo
jaws compressed from side to side, to the thinn
of a knife-blade, the lower being considera
longer than the upper. The bird flies just ab
the surface of the water, with the lower elonga
portion of the beak thrust just below the surf

By this means it is enabled to catch up small fish from the shoals which swim at the surface.

One of the storks and also a small plover have the bill flattened from above, and expanded at the tip from side to side to form a sort of flat spoon, hence the name of spoon-bill, and spoon-bill plover. These both obtain their food from pools of shallow water. Another of the storks, the flamingo, has the beak bent down upon itself in a most peculiar way, so that the bird has to feed with the crown of its head turned towards the surface of the water in which it wades and from which it obtains its food. Even a long description could not make this quite clear. My readers, if not fortunate enough to live in Spain or Africa where these birds are common, must go to the nearest Zoological Gardens where they will see these birds and much more concerning them that is curious.

The humming-birds have very long, slender beaks, which are thrust up the long tubes of honey-bearing flowers, in search of the insects which come to feast therein. Sometimes these beaks are of such length that they exceed that of the body itself! We might add dozens more of such instances, but this would be wearisome. Enough has been given to show that only birds with beaks specially adapted can obtain food from those special sources; and thus, while these sources continue open, their existence — other things being equal—is assured. *But*, existence depends upon this. Should, by any means, these particular sources of food-supply fail, the birds are doomed to death, and the race to extinction;

whereas birds with a more generalised kind beak might possibly obtain food in some ot way—as the kea-parrot has done.

That the form of the beak and tongue is c to the method of obtaining the food, is prov if proof were needed, by the precisely analog structures found amongst animals in no p sible way related. Thus, the beak of the ha is matched by the exactly similar beak of octopus, a marine invertebrate. In both, organ is used for tearing up living prey. stances could easily be multiplied. That the m highly specialised form of beak is derived fro more generalised type is shown from the fact th humming-birds, spoon-bills, scissor-bills and so do not develop their peculiarities till late in life

There is at least one instance in which form of the beak differs in the two sexes. T case is afforded by the Huia bird of New Zeala That of the male is short and stout, that of female long, slender and curved downwar They feed on grubs obtained from more or l decaying wood. The male, with his stouter b breaks away the decayed wood and so unear the concealed grub—this is not a pun! The fem probes the sounder wood and drags out her fo by force. Sometimes when the male hav cleared away all the decayed wood is yet una to reach his prey the female is enabled to do but, having done so, we are told she retai perhaps by consent, what she has procured.

If the beak is important to some birds, tongue is equally so to others.

The form and size of the tongue, like eve

other organ of the body, is capable of being slowly but surely modified and changed like clay under the thumb of the potter. Sometimes this change is one of progression, the tongue becoming more and more complex and more and more perfectly fitted for its peculiar purpose: sometimes it is rather one of suppression as the tongue becomes less and less in size, in proportion as the need for its existence decreases, till at last, as in our cormorant and gannet, only a mere vestige of it is left. For it is a fact that so soon as an organ ceases to be useful, so soon as it ceases to work, its fate is sealed and slowly but surely it is removed from the body, or remains an insignificant vestige by which all men may measure the distance which it has fallen.

We cannot do more here than examine a few of the more remarkable tongues.

Take the common duck for instance, a bird familiar to us all. The tongue in this bird is very thick and fleshy, and provided on each side with little horny plates, and at its tip with a kind of horny spoon. The horny bristle-like plates at the side fit into similar horny plates which form a sort of fringe round the inner edge of the beak; the purpose of these plates is to form a sort of strainer, by which the bird is enabled to strain off the water which it takes in with its food. The arrangement of these plates suggests that of the whalebone in the mouth of the whale, and are used for a precisely similar purpose. These plates are best seen in one of our fairly common wild ducks, called the shoveller. In this bird they are of great size.

The honeyeaters of the New Zealand Australian regions, the sun-birds of Africa, In and Australia, and the humming-birds of Amer have the most remarkable tongues of all bi They are much too complicated to descr Those who wish to know more about t should consult the various works on anatomy. Suffice it to say, that they resem one another, in that the edges of the r and left sides of the tongue are of extreme t ness and rolled up in different ways to form m or less complicated tubes. The exact use these tubes is even now a matter of disp Some hold they are for the purpose of suck up honey or nectar—after the fashion of the boscis of a butterfly which they rather clo resemble—and some, that their purpose i "coax" insects from the flowers whose ho they have come to feast on. Certainly ins are always found in the stomachs of these bi It may be that the birds really come for honey, and that the insects are swallowed intentionally, a sort of fortunate accident, mixture rendering the diet a more nourish one than would otherwise be the case.

Take the woodpeckers again, birds that be seen in almost any of our English wo Here the tongue has grown to an enorm length, so much so that it can be projected beyond the head. The bird feeds on ants. A exposing the nest or otherwise disturbing inmates, the long, worm-like tongue, cov with a sticky material secreted by glands the sides of the head, is thrust in amongst

frightened hosts, which, entangled in this substitute for bird-lime, are swiftly drawn back to be speedily swallowed. The skeleton which supports the tongue is of extreme delicacy and has to be stored away by being curled up round the head just under the skin.

A precisely similar method of feeding on ants has been developed by various mammals—the ant-eater for instance, and the echidna, or spiny ant-eater of New Zealand. Thus again we have more instances of exactly similar and independently acquired modifications of the same organs due to the need to perform the same functions. That is to say, the woodpecker and the New Zealand and South American ant-eaters are not even remotely related, yet, having adopted a similar diet, all have followed the same method of obtaining it.

There is a barbarous and old-time custom of splitting a bird's tongue to make it sing better; did those who practise this brutal custom but know it, they would be spared the excuse of performing this operation. The tongue does not improve the song, the organ of voice or song is at the lower end of the wind-pipe, concerning which we shall have something to say later. That it can have but little to do with the voice can be seen in the fact that the starling, the raven, the magpie, and others, all alike in having a hard horny tongue, can be taught to talk well, as distinctly as the most familiar example of all talking birds—the parrot, which has a large and

fleshy tongue, that might be well compare
our own.

But this chapter is to record how a bird f
and digests its food. We have seen now, I th
fairly clearly, how important a place the
and tongue fill in the matter of obtaining
food, and how these have been slowly mod
so as to assume strange forms, in response to
need of obtaining food otherwise inaccess
But some may ask, what is the evidence
these changes *have* taken place? This w
take too long to discuss. But we have
good witnesses in the birds themselves: one
see that a long straight bill can becon
long upturned one, or a long spoon-shaped
for the change is enacted before our eye
every avocet and every spoon-bill, and e
cross-bill and every wry-bill-sand-piper and e
humming-bird, and so on, that is born.
none of these birds are the bills of these pec
shapes at birth. They assume these var
forms later on in life; all begin with just ordi
beaks.

Just as the beak becomes changed from
form to another to enable it to do work
certain kind more efficiently, so the ston
and intestines become also changed. The
must work in sympathy with the other, acc
ing to the need in each particular case.

The form and structure of the intestine
alimentary canal generally, however, do
vary as the beak, but rather as the need
adaptation to a new food. Thus the form
the digestive organs of the spoon-bill, the avo

and the plover is the same, as the nature of their food is the same; though differing in the form and way it is procured. The beak has changed to enable it to obtain the same kind of food in a form inaccessible except to a beak specially modified for its capture. But the digestive organs of the plover, the ostrich, and the hawk, are very different, because the food they have to digest is different.

A detailed discussion on the digestive apparatus of a bird would be out of place here. Suffice it to say that it may be divided into four parts—a mouth, a gullet, down which the food passes from the mouth; a gizzard or stomach in which the breaking-up and digestion of the food is begun, and the intestines in which the process of digestion is completed, and from which it is taken by the blood into the body to build up the tissues spent in work.

In many birds, such as the pigeon and common fowl, the gullet is provided with a large thin-walled bag, called the crop. Into this considerable quantities of food are taken, to be used later. No digestion takes place here, but the food is softened by admixture with saliva; it is mostly a storehouse used by birds that have to take in much food at a time, and then retire to assimilate it. During this process of gathering the daily bread the bird is exposed to many enemies; thus an advantage is gained if it is able to take in a large store rapidly, and then retire slowly to digest it. In the same way bullocks, antelopes and sheep, have developed a remarkable stomach, which enables them to lay in rapidly a large quantity of food,

and then to retire and quietly digest it by
process known as "rumination," or "chewing
cud."

The hard seeds and nuts devoured by
pigeon or the fowl are slowly passed on to
gizzard, where they are gradually broken up
again passed on to the intestine, to be fin
absorbed as food — a beautiful instance
division of labour. The gizzard in these b
is a large, muscular (fleshy) organ, the w
of which are of great thickness, and the inte
of which is armed with two horny pads. T
are made to rub one against another, after
fashion of millstones; their work is further a
by small stones which the bird swallows on
pose, indeed without these it is doubtful if di
tion could proceed. The gizzard and its st
serve the bird in the place of teeth for mastica
its food.

There is a South American bird—the hoatzi
which has so far upset the order of things a
make its crop do the work of a gizzard. In
transformation, it has thickened its walls, and
come hard and horny inside. Following on
another change has taken place. The we
of so much food, retained so long as it n
be in the gizzard, has brought abou
gradual decline in the form and size of
merry-thought, between the arms of which
ordinary birds, the crop lies, and of the bre
bone, so much so that the bird's power of fl
has become seriously hampered, why, we s
see later.

In the stomach (gizzard) of the great cre

grebe, one of our British birds which lives on fish, we never find stones, but only feathers. Why this should be so has never been explained.

The stomach of our common cuckoo appears to be lined with hairs when opened. Examination shows them to be the hairs of certain caterpillars, which only this bird can eat.

We have discussed the instruments by which the food is seized, and taken a peep into the mysteries of its digestion, let us, for a space, try and learn something of the means by which it is procured, and of the method by which it is discovered.

In the case of some birds, it is difficult to say whether sight or scent plays the more important part. The vulture in the past furnished material for much controversy on this point. Waterton, that most delightful of old-time naturalists, devoted much attention to this very subject. He held it proved beyond doubt that this bird discovered its food by *scent*, and not by *sight*. The vulture it must be remembered feeds only upon dead and more or less decaying animal matter, so that there would be no mistake about the smell as a feature of his diet! He argued out his case at some length. Most of us now are inclined to believe that Waterton, for once, was wrong. We hold with the view that he tried to oppose, that the bird depends entirely upon sight: a faculty which is developed to an extraordinary degree in these birds. Vultures, as is well-known, collect in large numbers in an incredibly short time on a spot where a few hours before not one was to be seen. For instance,

should a camel in a caravan fall out to die o
way through the burning desert, the fact seem
be communicated to every vulture in the cou
as if by magic, and lo! in a short while they
gathered for the feast, and wait—ghoul-like—
the end. It is supposed that the prospe
meal is discovered in the first instance by per
a single bird soaring, as they are wont, a
enormous altitude. The movements of the
are watched by a second at an equal eleva
but yet further off, and thus by a third, and s
till one becomes a crowd. This has been be
fully expressed by Longfellow in "Hiawatha

Some birds, like our common British s
and woodcock, and the New Zealand apte
find their food by the sense of touch, or in
case of the apteryx perhaps by smell also.
both cases it is hidden from view, inasmuc
it has to be obtained by thrusting the beak o
into soft ground in search of worms and s
like animals. But for the sense of touch
obvious that feeding from such a source woul
impossible. The beak of the snipe, if exami
will be found very soft and pliable; disse
shows it to be richly supplied with nerves.

Tradition has it that snipe and woodcock
on "suction." Consequently, they are co
without the removal of the intestines or "tr
The cookery-books bid us "toast and butt
slice of bread, and put it under them for
trail to drop on." It is doubtful whether,
were known that this trail was stuffed with
or less digested earthworms, this fashion of c
ing would be so religiously followed!

To return for a moment to the sense of sight in procuring food. How keen must this sense be in the hawks and eagles. Take one of our commonest birds of prey, the little kestrel. Who has not admired its wondrous poise high in air with quivering wings, yet never moving from the same spot, till suddenly there is a downward plunge, swift as an arrow, and we know that a mouse has gone the way of all flesh: in one sense at any rate! Yes, though the bird is so high up as to appear little more than a speck in the sky, yet he has discerned, and secured, from that high altitude, a prey so small! This keenness of vision depends upon the beautiful power of compensation which the eye possesses: like a telescope, only infinitely easier, it can be focussed to suit near and distant objects at an instant of time.

The kingfisher of our river sides, the osprey of our lakes, and the gannet of our coasts, all discern their prey—fish large or small—from a distance, and seize it by a quick lightning-like plunge below the surface. The force with which this is done is well seen in the gannet, though by a cruel experiment. Sailors often tie a fish to a plank and set it adrift near these birds, suddenly there is a wild plunge, the fish is struck and the bird—is slain. The force with which it strikes the wood breaks its neck.

The cormorant, like the penguin and the darter, is a most deadly fisherman. The Chinese take advantage of its skill, turning it to their own profit. They train, and set it to catch fish. That it may not swallow what it catches,

a rubber ring is placed round the neck so
the bird is bound to come to the surfac
disgorge it. Every now and then it is allo
to keep one as a reward.

Having now learnt something of the hun
that scour the face of the earth, and "of
waters under the earth," and of those who d
into the solid ground, we may profitably
passing, take a brief survey of the domai
that lighter liquid that surrounds the eart
the air. The children of the air—the
children—are not always the children of li
for some hunt only during the reign of twili
And they are loved none the less on this acc
by those who know them. On the contr
some of us love them more, they fill a plac
our affections which the others cannot sh
They are a part of some of the best and r
restful moments of our lives. When the
and glare of the long summer day has pas
and all is quiet and hushed, they break
upon the stillness and give it life. Who
not love to remember, having known them,
"churring" of the night-jar taking toll f
amongst the ranks of the lazy, humming, help
dor-beetles and cockchafers; or the delir
scream of the bow-winged swift, as he ru
with a score companions down the village str
and round the ivy-clad church-tower, snapping
as he goes along, flies, gnats, and other win
things too tiny for our eyes to see. They h
burnt themselves in upon our memories,
rise at our bidding fresh as ever.

Amongst the "children of light" we h

many friends: the swallow, and martin, sand-martin and fly-catcher. Not one of these will deign to touch the earth to take from it one morsel of food, but captures it in passing through the air.

We referred, in an earlier part of this chapter, to the butcher-bird or shrike as it is more properly called. This, like the nut-hatch, is peculiar in that it often has to resort to a mechanical device to enable it to attack and demolish its food. The shrike, which feeds largely upon small birds, mice, frogs and beetles, transfixes these upon sharp thorns, then proceeds to tear pieces from them, leaving the remains to rot in the sun. Usually it keeps to one bush, at least for some time, for this purpose, and consequently the effect is rather ghastly after a while. The hawk, which feeds upon similar food, holds it by both feet; but the feet of the shrike are perhaps not strong enough for this purpose.

The nut-hatch, one of our woodland, as the shrike is one of our hedgerow birds, seems only to have recourse to artifice when feeding on nuts or hard seeds. Its chief diet is of insects. Nuts it breaks open by thrusting them into chinks and crevices in the bark of trees, and then, taking firm hold of the bark with both feet, it uses its beak as a sort of pick-axe, hammering away until the shell breaks and the coveted kernel is exposed. The noise made during this operation is considerable. The nut-hatch seems to know instinctively a sound nut from an empty shell without breaking it. Out of a liberal supply

of nuts which were placed in a tray that w
fixed outside the window of the rooms of a frie
of the writer in Merton College, Oxford, for
special benefit of these birds, several were alwa
rejected, and these when opened were found
be empty, without exception.

In noting of these habits, we must not for
that gradations leading up to them are
wanting. Thus, the thrush brings snails
some large stone whereon to beat them
the shell is broken. Many birds are in
habit of softening food with water bef
swallowing. Crows will carry shell-fish h
into the air then drop them on to the ro
below to break the shell.

Some birds live largely by the exertions
their weaker neighbours. The skua-gull,
instance, is one of the most persistent of th
pirates. Powerful and bold, he waylays
cousin the sea-gull when returning from
heavy meal, and the latter, to escape, lighte
his weight by disgorging his too recen
swallowed dinner. Swift as light, the sk
descends, and catches it before it has reach
the sea.

CHAPTER IV.

BIRDS' FLIGHT, AND BIRDS' WINGS.

We are wont to regard ourselves as the "Lo
of Creation," and to speak of all other livi
things as the inferior animals. Yet a few
these, in one respect, are a constant source

humiliation to us. For many generations man has been sighing, with David, for the wings of the dove—or some other bird—that he too might rise as they rise, and soar as they soar, at will from one new sphere to another; that he might at will change the fog-laden atmosphere of a crowded city for the bright blue skies and sunshine of the open country. But he has sighed in vain. Many have been the attempts and as many the failures to accomplish this and success seems almost as far off as ever.

The power of flight, as a moment's reflection will remind us, is by no means confined to the birds. The butterflies and moths, flies and beetles, and the bats, in our own class—the mammalia—are all superb fliers. All fly by means of wings, but—and this has probably never before occurred to many of my readers—these wings are not in all cases of precisely the same nature and origin. The wing of the butterfly or of the bee, when compared with that of the bird or the bat, is said to be an "analogous structure"; but the wings of the bird and bat homologous structures. To put it more plainly, when we say that the wing of the butterfly is analogous to, or is the analogue of, the wing of the bird, we mean that the two organs perform the same function—of sustaining the body in the air, but that they are of different origin; whilst the wing of the bat and bird are of the same origin, or are homologous. For instance, the bat and the bird, like the horse or the dog, or ourselves, have each four limbs,

which we call—the fore- and hind-limbs of th horse and dog, the arms and legs of the man the wings and legs of the bird or bat. Th wings then are homologous with our arms, an the horse's fore-limbs; they are developed fro the same parts in the unborn young or embryo The butterfly and the bee have six legs, whic cannot be compared with our legs, except i so far as they perform the same function of sup porting the body. The wings certainly the cannot correspond to our fore-limbs. Moreove there is some evidence tending to show tha the wing in these last is a highly specialise and modified *gill*.

The plan upon which the bird's wing is bui is quite different. Let us compare it with ou own arm and hand. The wing of a bird the and the "arm" of a man are precisely similar i kind, but the former has become much mo highly specialised or modified, so as to perfor the office of a wing. To this end, as we sha see, certain fingers have been lopped off, and th remainder so altered as to be scarcely recogni able. The wing and the arm are both divisib into three main divisions: (1) the long sing bone from the shoulder to the elbow called th "arm"; (2) the two long bones from the elbo to the wrist called the "fore-arm"; and (3) th series of bones from the wrist to the finge which make up the hand! It is in the form the wrist and hand that the bird differs fro ourselves. The bird has retained but three his original five fingers. One of these forms th tiny thumb; the second or index finger, and th

third or medius, have become immovably joined together; whilst the lower end of the third finger has become reduced to a single tiny bone buried beneath the skin; so that at first sight there appears to be but a thumb and one finger on the hand.

Along the hinder border of this hand, and along the same region of the fore-arm, run a number of large feathers—the quill or flight feathers. These are divided into two series, those of the hand being called the primaries, those of the fore-arm, secondaries. On the form and length of these quills depends largely the nature and the power of the flight.

Those of my readers who happen to be sportsmen or dwellers in the country will readily call to mind some four quite distinct forms of flight. The 12th of August or the 1st of September or October will furnish them with many a vision of the first kind—that of birds with heavy bodies and short rounded wings. The whirr of wings of a covey of partridges in full career is not easily forgotten. One has but to shut one's eyes and touch the spring of the proper compartment of one's mental picture stores to revive, with a vividness that cannot be equalled by the cinematograph, a whole series of scenes. Turnip-fields and stubbles, dogs and beaters, the flash and report of guns, and the call of frightened birds that have just alighted into fresh cover. And in this we have a lesson not easily effaced, a lesson from which we derive two important deductions: (1) That birds with short rounded wings and heavy bodies fly rapidly; (2) drive

the wings with great velocity and power; a
do not fly far.

Those who know the partridge should kn
also the lapwing and the owl, the heron and t
gull. These are all birds having a relative
small light body and large wings. They will
able to picture the slow majestic long-sustain
flight of the heron, or the fairy-like movemen
of gull or tern now skimming over the shi
waters of the sea or lake, and now mounted hi
in air and wheeling round and round, as if f
the mere delight of moving. We find in the
an object lesson in the second form of flight.

To see the third form we shall have to mo
further afield than our own shores. We mu
seek out the albatross and the pelican, bir
whose bodies are heavy and whose wings a
long—in the case of the albatross, ribbon-like
and moved with a decidedly slow and rhythmi
beat. Concerning the prowess of these on t
wing we shall have something to say presently.

This classification by no means covers all t
varied forms of flight. It is rather meant to
an indication of the fact that the nature of flig
varies much in different groups of birds.

So far, that of which we have spoken has h
reference to direct movement with a purpose,
to speak, to a deliberate passage from one poi
to another. But there is yet another form
flight quite different, and this is known
"soaring."

The masters of this art are, by common conse
the vultures, pelicans, and the storks; the ran
of the last claiming the finest performer of the

all in the adjutant stork. These birds are said to rise at first from 100 to 200 feet by the movement of the wings; and then, without the smallest perceptible movement of the wings, sweep round and round in elegant spirals with the wings and tail fully spread. During the first part of each turn of the spiral they sail with the wind, and in a slightly downward direction; at the end of this fall they sweep round and face the wind which bears them upward. They gain from ten to twenty feet at each turn. When the course is towards the left we are told the left wing is downward and the right upward, but the two wings always form one rigid rod, moving only as the body moves.

Thus they attain an elevation of from one to two miles—the condor, one of the vultures, sometimes rises six miles—and so restful does this exercise appear to be that the birds are believed by some to go aloft to doze. The soaring of the albatross has been most graphically described by Captain Hutton. He says, "I have sometimes watched narrowly one of these birds sailing and wheeling about in all directions for more than an hour without the slightest movement of the wings, and have never witnessed anything equal to the ease and grace of this bird as he sweeps past, often within a few yards, every part of his body perfectly motionless except the head and eyes, which turn slowly and seem to take notice of everything."

Soaring birds in this country are now rare indeed. Only where the buzzard still holds his own can we occasionally watch this beautiful

flight. One quite peculiar type of soaring, if i
can really be accounted soaring, is that of th
skylark: and this is performed to the accompan
ment of the sweetest music that can be heard
even in this world of songsters, as the bir
world is. Who has not watched, with upturne
eyes, its spiral ascent till it becomes a mer
speck; and often even this is lost, and th
songster vanishes, naught but those exquisit
notes sinking down from heaven to earth ser
ing to indicate its whereabouts.

There yet remains one other form of fligh
about which we must say a few words. This
known as hovering. It is the very antithesis o
soaring, though sometimes it is performed a
great altitudes.

In soaring the wings are held more or les
motionless, and the effect is to carry the bod
higher and yet higher. In hovering the wing
are driven at enormous speed, yet the bir
remains poised over a given spot. The wings o
the humming-bird when feeding, suspended as
were beneath the mouth of some honey-lade
flower-tube, dropping honey as the cloud's fa
ness, move so rapidly that it is impossible fo
the eye to follow each stroke, and a hazy circl
of indistinctness on each side of the bird is a
that is perceptible.

In our common kestrel hawk again we hav
a superb exponent of this feat. So well know
is he on this account that he is popularly know
as the "wind-hover."

Hovering however differs from soaring in thi
—it is always done in order to find food; soa

ing is often performed—always perhaps except in the case of the vulture—for the sake of rest, or the mere pleasure and joy of living.

Concerning the speed of a bird in full flight we know but little.

We have records however of the feats of homing-pigeons and of swallows, many of which have been ridiculously exaggerated. Thus, Pliny tells of a certain Roman knight who wished to convey to his friends at Volterra, in Tuscany, the result of the chariot races in Rome, and for this purpose took swallows with him. A swallow sent from Roubaix to Paris—160 miles—is said to have covered the distance in 90 minutes, a speed of 106 miles per hour! It is stated that one of the racing homing-pigeons in 1892 accomplished a flight of 114 miles at a rate of 80 miles per hour. In the same year a flight of 82 miles is recorded, the rate of the speed attained being 71 miles per hour. Thirty-six to fifty-six miles per hour for a course of 208 miles was the average of the winning birds of the United Counties Flying Club in 1883. High up in the air it is probable that a bird can attain greater speed than near the ground, and that this moreover can be sustained for long periods. Thus the American golden plover on migration is said to cover over 1700 miles in a single night!! As Mr Headley an authority on this subject says, "Even if we assume an average of 60 miles per hour, the birds would be over 28 hours on the wing."

Gätke, a great German ornithologist, who spent

a lifetime in observing bird-life in Heligolan believed that the Arctic blue-throat can lea Africa at dusk one evening, and arrive in Helig land nine hours after, travelling 1600 miles du ing the night, which gives, as Dr Sharpe mild comments, "the almost miraculous velocity 180 miles per hour." This is a prodigious pe formance to assign to little birds of the size our robin.

This same authority (Gätke), by the way, estimating the time taken by plovers and cu lews in the flight from Heligoland to oyst beds, some four English miles distant, calculat that they accomplished this distance in o minute, or at the rate of 240 miles an hour

The speed and power of the flight depend up the size of the muscles which move the win These muscles are of great size, and familiar us all in the shape of the breast of the fowl duck, for instance. The weight of these in re tion to all the rest of the muscles put togeth varies. Mr Headley found that in pigeons th represented just about one-fifth of the to weight. For the purpose of attachment of the muscles, the breast-bone in these, and in all bir that fly, has developed an enormous plate of bo called a keel, from its resemblance to the keel a ship, the hull being represented by the bo of the breast-bone.

There are one or two points concerning t wings of nestling birds that are well wor noting.

In South America there lives a bird called t hoatzin, about which we are still puzzled.

nestling is remarkable in one or two respects. When newly hatched the thumb and first finger are armed with long claws, by the aid of which it climbs out of its nest,—which is built in dense shrubs and trees overhanging the water,—to meet its parents coming with food. Day by day certain of the quill or flight-feathers of the wing grow longer and longer, but only about half of the proper number are represented in the hand. The development of those near the tip of the finger is held in abeyance for a very considerable time, until the inner ones have grown long enough to break the force of a fall should such an accident take place. So soon as this assurance against accident has come about the outer quills grow rapidly, and the claw of this finger drops off, there being no further use for it. The benefit of this law of growth is obvious. If the outer quills grew at the same rate as the inner ones, the wing would in a few hours be useful neither as an organ of flight, nor as an organ of prehension, for the wing area would not be large enough to support the body, nor would the claw, on account of the premature development of the quills, be enabled to grasp objects. Yet another change follows the loss of this claw. In the nestling the hand is longer than the forearm, in the adult the hand is shorter than the forearm. The whole wing, in short, in the adult bird, is of a degenerate character.

The hoatzin builds in trees, and passes its whole life therein. One has never been known to alight on the ground. If a nestling should happen by any chance to fall into the water,

it escapes by diving or swimming, which does to perfection. So far as is known, should be remarked, the adult does not swi

The wing of the nestling chicken furnis us with an admirable lesson in deduct zoology.

As in the hoatzin, the outermost quill feath of the hand are not developed till a comparativ late date, the inner ones meanwhile grow rapidly; and just as in the hoatzin, so soon these are long enough to enable the bird to t a short flight, so soon do the outer quills be to grow. But the hand is relatively shorter, the finger has no claw. The first point wo suggest that the reason for this arrested deve ment of quills was due to the same cause in b cases, the need to have the finger-tip free for purpose of grasping objects. The second— absence of the claw on the first finger—wo appear to contradict this, or at least to be obstacle. If we turn to the embryo, howe we get confirmation of our original hypoth —that the wing in the chick was at one t used, like that of the hoatzin, for the purp of climbing before it was used as a wing, asmuch as the missing claw in the first finge now present. It disappears before the bir hatched, there being no use for it during nestling period. In course of time, a very l time, it will probably be entirely suppres so that no record whatever will remain.

Not only in the chick does this happen, also in the pheasants and partridges and t allies. From this we infer that once upon a t

the ancestors of these birds were strictly dwellers in trees, and that the existing representatives of these have since become dwellers on terra-firma. Thus then we get from those two small points a whole flood of light illuminating the past history and the evolution of the whole group.

We shall find even more convincing evidence of this later on in these pages.

There is one other point in connection with birds' wings which should certainly receive mention here. It has puzzled and baffled all attempts at explaining it for the past twenty years.

Exactly so many years ago, one Gerbe, a Frenchman, discovered that in certain birds, such as pigeons, gulls and parrots, for instance, one of the quill-feathers of the forearm appeared to be missing—No. 5. Ten years later, this same fact was re-discovered and this time by an Englishman named Wray. Like Gerbe, he held that the particular quill in question was actually missing, and sought amongst all orders of birds hoping to find some sort of a vestige of it, but in vain. The reason for assuming a lost quill lay in the fact that in these wings every pair of greater coverts of the wing embraced a quill between them save the fifth pair, between which was no quill.

The word diastataxic has been coined to signify the absence, and eutaxic the presence, of this quill.

It has since been shown that there really is no quill missing, but that it has changed its relations with the neighbouring feathers. Exactly how this is done would be too long and too

technical to explain here. The mystery, ho
ever, is even yet not quite cleared up. T
subject is one well worth the attention of th
fond of puzzles.

Most of us probably regard a bird's wings
the only parts of its body concerned in its flig
As a matter of fact, flight has two powerful au
liaries in the shape of its lungs and air-sacs.

The former, which are very large, are pecul
in more ways than one. In the first place, th
are not more or less freely suspended in
body cavity, as in other animals, but fitted clos
to the back. So much so, that when dissec
and taken out of the body they are found to
marked by deep grooves or tunnels indicat
the shape of the ribs, in between which they h
forced themselves. In the second they are
versed by numerous tubes which open eventua
into large thin-walled bags placed along e
side of the body, and called air-sacs. These
sacs were believed at one time to be for
purpose of making the bird lighter when in
air; but the amount of difference which t
make in this direction would be inapprecia

They probably serve as a reservoir upon wh
the bird can draw during the violent exertion
flight, or singing, and for regulating the b
temperature.

In many birds even the bones of the skele
are hollow and filled with air from the air-s
This again was supposed to be a powe
auxiliary to flight; but, when we recollect t
some of the most powerful fliers, like the sw
the swallow, and the albatross, have marrow

the place of air, like ourselves, we see that this cannot be the true explanation.

Sometimes the whole body is thoroughly permeated with air. It runs in little bags between the muscles of the body, and between the skin and the body to a most extraordinary degree. The common gannet of our shores, the pelican, and the South American "screamer" are good examples of this.

CHAPTER V.

FLIGHTLESS BIRDS AND THEIR FATE.

To appreciate fully the significance of the fact that there are birds to whom the power of flight is impossible, that have never known what it is to soar above the clouds, but who have been confined, as were their ancestors, for countless generations to Mother Earth, we must imagine a race of men, or a family of men, who have never walked. Yet there are such birds, and it is of them that we are going to speak now.

We have seen in the previous chapters how different organs, or parts of the body, change their shape, taking on new forms to adapt themselves, as the need arises, to new surroundings or new food. In all these cases the result of this adaptation has been an increase in the complexity of the organ.

With every part of the body in the same way, so long as each particular organ continues to be useful, so long as the organism has need of it,

so long as it gets its proper amount of exerc and nourishment—and the latter largely depe upon the former—just so long will it rem vigorous. More than this, it will respond wit certain limits to new demands upon it, a change its form or function accordingly. B so soon as its usefulness becomes lessened, a its exercise diminishes, its nourishment is slo withdrawn, and it gradually but surely starts its downward path. Growing smaller and weak and losing more and more its characteristic sha and beauty in each generation, it soon is redu to a mere vestige, and even this is sometim lost. We may then remain in entire ignora of its ever having existed, or may have attention directed to its loss by reason of presence in its nearly allied species.

The following brief review of flightless bi will afford us an excellent study of the resu more or less direct, of use and disuse.

The power of a bird's flight is probably in portion to its need in procuring food and esc ing enemies. The one plentiful and near hand, and the other removed, it would seem t each of the birds, about which we are to sp presently, insensibly settled down to a comf able, easy existence, seldom or never exercis its wings. The flight necessary to procure daily bread was also often a means of enjoym pure and simple, without any such gross moti But this source of pleasure was smothered ever in that evil day which placed food wi too easy reach and banished enemies to the l of oblivion. As a result, the children of

third and fourth generation have been called upon to suffer, flight to them being impossible.

In the course of the next few pages we shall see how gradually changes of this kind come about. In the domain of flight we have every gradation of power and speed, from the arrow-like velocity and skilled performance of the swallow to the feeble flutter of the hoatzin, the South American bird, whose whole life is spent on low trees by the water-side. So far as is known, this bird never descends to the ground, and never takes a journey of more than 100 yards on the wing at a time. It is said to jump from the highest point available, and then gradually to descend until he alights upon the desired bough, beyond and below.

In that other bird world where wings are, or have been, but flight is not, we shall see similar gradations, but this time they will be gradations of *im*perfection. We shall see the wing growing smaller and smaller, and one by one its bones fading away and its feathers vanishing, till finally it will altogether cease to be. We shall in some cases be able to determine approximately the date at which this phase of degeneracy began.

It will be necessary here to refer once again to certain points in the structure of the skeleton of these flightless birds, and to compare these points with similar others in those birds in which the power of flight yet remains unimpaired.

In the last, as already mentioned (p. 64), the power of flight is largely commensurate with the development of the breast muscles,

and the bones of the skeleton which suppo
them.

These comprise a breast-bone, a pair of lon
bones which are fastened on to its front end,
pair of shoulder-blades fastened on to the ends
these, and a merry-thought.

In birds that fly well there is a deep thin ke
running down the breast-bone. This keel
familiar to us all in the fowl or duck as the bon
partition which divides the flesh of the left an
right sides of the breast. In birds that ha
lost the power of flight, this keel, if the loss
recent, is small, if of long standing it is abse
altogether. The merry-thought again is absen
or feebly developed in birds which do not f
much or well, or which are quite flightless. T
long bone which we referred to as being fasten
on to the end of the sternum, is called t
coracoid. We shall have occasion to refer to
again later. This in flightless birds may becon
immovably fixed to the blade-bone, and the ang
which the two form one with another is also
point of some significance.

Just as the bones supporting the breast-muscl
shrink away, so to speak, though lack of use,
also do the bones of the hands and arm.

As examples of birds that have but recentl
comparatively recently, lost the power of fligh
let us take, first of all, the New Zealand kaka
or owl-parrot.

This is a fairly large bird for a parrot, and o
of great and increasing rarity. There can be
doubt that it once lived in trees, like other parro
and probably like them needed well develop

wings to escape its enemies, and get from one feeding-ground to another. In an evil hour, misfortune in the guise of blessing overshadowed the kakapo, and removed these two stimuli to healthy exercise, with the result that indolent habits formed themselves, and slowly stole away Nature's wondrous gift of flight. At the time the kakapo settled in the island, there were no flesh-eating mammals, the bird's natural enemies, whom they can only successfully resist by taking to themselves wings. But for the mammals we should have many more birds in the same plight as those discussed in this chapter. Food is generally procurable from the ground even by birds which feed in trees. To avoid prowling beasts they ascend the trees and pluck their food from the branches—nuts, fruit or whatnot —as the case may be. In the absence of such terrors they can obtain it in plenty when it falls. This has been the undoing of the kakapo. The hole in the ground or the cleft in the rock now serves this parrot for the hole in the tree. He can ascend these if he will, but with labour, for he must climb them. It is probable that some enemy, some danger, has threatened him since he became thus helpless, for now he has turned night into day, and feeds during the hours in which he once slept. In this way he has managed to hold his own. Recently, since the advent of Europeans into his domain, things have gone hard indeed, for new enemies, in the shape of pigs, dogs, and so on, have been imported, and from them there is no escape. They devour the eggs and young. His doom is sealed.

In Australia there are kinsmen on the wa towards the same doom. These are little groun parrots, whose power of flight, for reasons sim lar to those just recited, is slowly decreasing.

There is a point which is well worth notin here, concerning what we may call compensatio for this loss of flight, but a sadly disproportionat one. To wit, in all markedly arboreal or tree haunting birds the legs are very short indeed Take the pigeons, the parrots, the cuckoos, an the hornbills as instances. In all of these cer tain of their members have fallen away and los their first estate, and now walk the earth weari instead of winging their way above it as fanc led them. In just so many instances have th legs become conspicuously longer; and from thi fact only we could tell that they were to b written off as representing the poor relatives o the family—the failures and the fallen ones Many of these fly no more, the remainder bu indifferently.

The wood-hen, or weka rail of New Zealand is another of these flightless forms; its wings though moderately large, are of no use as organ of flight. Yet another of these forlorn ones wh seem "to live, desiring without hope," is th large gallinule or water-hen *Notornis*. This bir is further remarkable in that it was first describe as an extinct fossil bird, probably flightless Years after a living specimen was captured, an within the last year yet another has bee captured. It is probable, however, that it i now almost or quite extinct.

The dodo, the solitaire, and the great aul

are all instances of flightless birds which have suffered extinction within the memory of man, in the case of the last-named, within the present century.

"As extinct as the dodo" is a very familiar simile, but probably few know what manner of bird — or if indeed it is a bird — they speak of. This remarkable bird was an inhabitant of Mauritius—an island in the Indian Ocean to the east of Madagascar. It was, the old travellers tell us, of about the size of a swan and of great stupidity. Our best descriptions of the bird in a living state come from the Dutch. Specimens undoubtedly were brought over to Europe and exhibited as curiosities, and one or more of them sat for its portrait not once but many times. One of these pictures, and of the birds at least two, were brought to this country. One of the birds seems to have found its way into the dissecting room, and another was exhibited alive in London in 1638. Sir Hamon Lestrange —to quote an article on this subject by Professor Newton—says, that as he walked London streets he saw a picture of a strange fowl hung out on a cloth canvas, and on going in to see it found a great bird kept in a chamber, "somewhat bigger than the largest turkey cock and so legged and footed, but shorter and thicker." The keeper called it a dodo, and showed visitors how it would swallow "large pebble stones . . . as big as nutmegs." It is probable that this found its way eventually to Oxford among a collection of stuffed birds. In 1755 its remains were seriously threatened

for it was ordered to be destroyed. Fortunately its head and right foot were preserved and these now adorn the University Museum, together with a picture by Roelandt Savery.

The extinction of the dodo is said to be due to the importation of pigs which overran the island and devoured its eggs and young.

To get an idea of how greatly the wing has degenerated it is necessary to compare it with its leg or with the wing of some existing pigeon. One can see at a glance how disproportionate the one is to the other, and thus gain a standard of measurement absolutely reliable. The dodo was really a gigantic pigeon. So also was its kinsman and near neighbour the solitaire.

Strangely enough, although the name of the solitaire is almost unknown outside scientific circles, whilst that of the dodo is almost a household word, yet we know far more about the former than the latter. We owe much of this information to the traveller Leguat who published an account of his travels in 1708. "Of all the birds in the island," he says, "the most remarkable is that which goes by the name of the 'Solitary,' because 'tis very seldom seen in company. . . . The feathers of the males are of a brown-grey colour; the feet and beak are like a turkey's but a little more crooked; they have scarce any tail, but their hindpart covered with feathers is roundish like the crupper of a horse; they are taller than turkeys. . . . They never fly, their wings are too little to support the weight of their bodies. . . . Though these birds will sometimes very familiarly come up near enough

to one, when we do not run after them, yet they will never grow tame. As soon as they are caught they shed tears without crying, and refuse all manner of sustenance till they die."

"We find in the gizards of both male and female a brown stone of the bigness of a hen's egg. . . . We believe this stone was there when they were hatch'd, for let them be never so young you meet with it always. They have never but one of 'em, and besides the Passage from the Craw to the Gizard is so narrow that a like Mass of half the bigness could not pass. It served to whet our knives better than any other Stone whatsoever. . . ."

"All the while they are . . . bringing up their young one, which is not able to provide for itself in several Months, they will not suffer any other Bird of their Species to come within two hundred yards round the Place: But what is very singular is, The Males will never drive away the Females; only when he perceives one he makes a noise with his Wings to call the Female, and she drives the unwelcome Stranger away, not leaving it till 'tis without her Bounds. The Females do's the same as to the Males, whom she leaves to the Male, and he drives them away. We have observed this several times, and I affirm it to be true!

". . . We have often remark'd that some days after the young one leaves the Nest, a Company of thirty or forty brings another young one to it; and the new fledg'd Bird with its Father and Mother joining with the Band march to some Bye Place. We frequently follow'd them,

and found that afterwards the old ones went eacl
their way alone, or in Couples, and left the tw
young ones together, which we call'd a Marriage.

Another very remarkable flightless bird is th
steamer-duck (*Tachyeres cinereus*), of the Straits o
Magellan. Captain King who has given us a very
vivid description of its habits, writes ". . . be
fore steamboats were in general use, this bird
was denominated, from its swiftness in skimming
over the surface of the water, the 'race-horse.
. . . It is a gigantic duck, the largest I have me
with. . . . The principal peculiarity of this bird
is the shortness and remarkably small size of th
wings, which not having sufficient power to rais
the body, serve only to propel it along, rathe
than through, the water, and are used like th
paddles of a steam-vessel. Aided by these and
its strong broad-webbed feet, it moves with
astonishing velocity. It would not be an ex
aggeration to state its speed at from twelve to
fifteen miles an hour. The peculiar form of the
wing, and the short rigid feathers which cover
it, together with the power this bird possesses o
remaining a considerable time under water, con
stitutes a strong link between the ducks and the
penguins. . . . When alarmed, they lose no time
in getting up steam, paddling through the water
at a marvellous rate by dint of flapping their
little wings, the motion of which is so excessively
rapid that it is difficult to convince one's self
that they are not revolving, leaving a long wake
of foam like that produced by a miniature steamer
behind them. . . ."

Mr Darwin believed that in this paddling

exercise the wings were moved alternately and not both together as in other birds. The maximum weight of a steamer-duck he estimates at 12 lbs.

There is one really very curious feature about this bird. The young are able to fly till after their first moult, when the power is lost for ever.

The great auk, like the dodo, the solitaire, and a dozen more, is but a memory: stuffed skins and skeletons scattered throughout the museums of the world, and fewer eggs, being all that remain of what was once a numerous people. The great auk it should be said is a near relative of the razor-bill (*Alca torda*) and the guillemot (*Uria troile*), such as swarm now on our coasts, and whose eggs are gathered by the bushel every year. These fly well, but in the great auk the wings were so much reduced in size as to be useless for flight.

The great stronghold of this ill-fated bird was Newfoundland. Our first account of them in these regions dates from 1536. In those days there were no condensed foods and tinned meats, so that sailors were perforce obliged to lay in large quantities of such food as could be depended upon, more or less certainly, to remain wholesome for a considerable time. Meat had to be salted, and for months at a time only this form of flesh food was available. How soon such a diet would begin to pall, we, who live in these favoured times, can readily guess. But anything seems to have been preferable to the everlasting diet of salt meat and weevil-bitten biscuits. Moreover, their complaint was surely justified,

for this diet brought more than monotony with it; it came, accompanied by that great scourge of all who have to subsist long on salt food—scurvy. Consequently, at every port of call fresh meat and vegetables were eagerly sought for. Sometimes these were to be purchased of the natives, civilised or otherwise, of the particular port. Sometimes they helped themselves freely at the expense of Nature's children. These were often so guileless, so unused to the presence of man that they felt no fear of him, and he went in and out amongst them and slaughtered at his will. It is to be feared that this freedom more often than not stirred up the brute within him and he got the lust of killing for killing's sake.

But this is a digression. The extinction of the great auk is one of the very few cases which can in a measure claim our forbearance. But even here greed was present, more were slain than need have been. In a work published in 1620 entitled "A Discourse and Discovery of Newfoundland," we read that "among the water-fowl which are very plentiful, are 'penguins' (the name by which the great auk was generally known) which are as bigge as geese and fly not, for they have but a little short wing, and they multiply so infinitely, upon a certain flat island, that men drive them from thence upon a board, into their boates by hundreds at a time as if God had made the innocency of so poore a creature, to become such an admirable instrument for the sustentation of man."

On Funk Island these birds were discovered in 1534, and could then be reckoned by thousands

For more than two hundred years they were subjected to a ceaseless persecution, till at last they were exterminated. On this island, it is said, it was the custom for the crews of several vessels to spend the summer for the sole purpose of killing "gare-fowl" (another alias of the great auk) for the sake of their feathers. Stone-pens were erected into which the birds were driven like sheep, to be slain by millions, and their bodies left to rot where they lay.

Two motives thus seem to have been at work, bringing about the destruction of these poor helpless fowl. Let us hope the need of food predominated; the evidence so far seems to point this way.

The great auk appears to have been exterminated in this quarter of the world before the beginning of the present century.

As a British bird it was nowhere plentiful, the last seems to have been captured alive in Waterford Harbour in 1834. It was kept a prisoner for some time, and on its death became one of the chief ornaments and treasures of the museum of Trinity College, Dublin.

The ostrich and the rhea, the emu, the apteryx and the moa, serve us with more instances of flightless birds.

The wings of the ostrich have not yet ceased to be useful though they no longer serve as organs of flight. They are used now as balancers in running. For this they seem to be no mean aids. Job's description of this terrestrial flight is vivid: "What time she lifteth up herself on high she scorneth the horse and his rider."

The wings of the rhea again seem to be quit large—until we realise how great is the size o the body requiring to be lifted, and examine th skeleton of the wing, when it at once becom plain what a falling off has taken place.

In the emu and the apteryx we have an obv ously degenerate wing. In these it is so tiny a to require the most careful search in the livi bird to find it. But even here, small though the are, they are *bird's* wings, and modelled on th same plan as the eagle's. They have descende to greater depths than the wings of the ostric or the rhea, for they have lost the thumb an shortened up the hand till there is practical none left. In the old fossil diver *Hesperornis* (s page 186) not only the hand but the forearm w lost, leaving nothing but the humerus or upp wing-bone. In the moa's wing even this was los

We now come to our last flightless bird—t penguin—and this is one of peculiar interest.

It affords an admirable illustration of how organ gradually modified for some particul purpose — such as flight — may as gradual assume other functions and take on quite ne characters.

It is certain that the wing of the pengu was used once on a time for the purpose flight, for it is built upon exactly the sa plan as that of all other birds. Whatev points of difference there may be now, a obviously the result of a modification of t original structure, to enable it to perform mo efficiently its new duty — that of a padd Again, the wing serves as an admirable model

the results of the modification of the same organ in different animals for the same purpose. Or to put it in another way, it shows us how the need to overcome certain mechanical obstacles demands that every organism or part of an organism shall adopt one common plan of a nature demanded by the particular obstacle to be overcome. The superficial appearance in all, is as a result, the same, however different may be the underlying structures.

Let us take, first of all, one or two illustrations of the adaptation of animals originally very different one from another but now very similar.

Once upon a time, ages and ages ago, certain reptiles or lizard-like animals found life more tolerable and food easier to procure near the sea-shore, and occasionally in the sea itself. Of these some were more expert in catching food in the water than others. Some slight difference in their power of keeping out the water from the lungs, a broader hand, greater power of remaining for a long time submerged, and so on, gave them an advantage over their fellows which their offspring shared, and not only shared, but possessed in greater perfection. Exactly in so far as they became more successful in these respects, so in exactly the same proportion did they become more unlike their unsuccessful friends, and more unlike their own parents and grandparents. Eventually, after many generations, all obvious relationship was lost. This process of transformation was aided and hastened, by a weeding out, which worked by the gradual killing off of

all the less perfectly adapted. Some would die because they could not manage to breathe s well, or catch food, or dive so well as thei neighbours, and so on. These defects did no necessarily actually kill them before the norma limit of life was attained, but it would tend t make them less productive. Being weaker the could not so readily procure mates and woul die without offspring, leaving their more vigorou and less conservative brethren to carry on th race.

The final result of all these changes was long whale-like animal with smooth, naked skin large flukes or blades on its tail, a large fin o fins down the middle of its back, and four bi paddles representing four legs. If we dissecte one of these paddles we should find it was lik a huge thumb and fingerless glove, for insid would be several separate fingers; this glov moreover would be found to enclose more tha the hand; all the arm would be found inside it

If we could trace the history of such a que beast back by a series of portraits, as some us are able to do our ancestors, we should fin just as many surprises in the fashions of the old times as in ours. If we could get back the founder of the House we should find som thing very very different from the last of t line. Thus we should find the body cover with scales, the fingers quite separate, a distin arm and forearm, and a long and thin tail.

The name and all particulars of this found are lost in the mists of Time; the last of the li has long since followed him to the grave. H

remains we dig up occasionally in the rocks in the form of fossils, and we call them the remains of the ichthyosaurus—which means fish-lizard.

Later in the world's history, long after the ichthyosaurus had passed away, this same set of changes and transformations was re-enacted. Certain members of another house, also of ancient lineage, but of "bluer blood," played and fed, and brought up their children, and died upon the shores of ancient seas, till they grew more and more fond of it, and more and more dependent upon it; at last, their very existence hung upon it; they could live nowhere else. Like the sirens of old the sea-mother wooed and wooed and won them for her own. She grew more and more persuasive, her blandishments more and more telling, so that one after another of their family traditions were relinquished—quite unconsciously—and one after another new features were substituted, each one of which bound them to her more and more closely. Till eventually, they forgot they ever lived on land, and with this memory passed away all desire for any life other than that which they now lead.

The creatures in question, which we know as whales, and porpoises, and dolphins, in external appearance hardly differ from the old ichthyosaurus. The founder of their house had four limbs, a body clothed in hair, a long thin tail, and long ears. The hair has now been lost completely; of the four limbs, each with separate fingers, only two remain, corresponding to our arms. The separate fingers have been thrust again into the fingerless glove, the tail has de-

veloped a huge fin, as also has the back, and the ears have been cut off. The transformation is complete. The proud mammal has been brought to the level of the lowly fish, lizard, the conger eel and the shark.

Some other animals there are which have been more fortunate. The old sea-mother has succeeded in binding them to herself, but yet allows them to spend a part of their time on land, wherein the duties of the nursery may be attended to; for food they remain absolutely dependent upon her. These, too, have had to surrender more or less of their original characters and take upon themselves in exchange others more in harmony with their changed habits.

We have three such cases. One of these is furnished by the lowly reptiles, another by the more well-to-do birds, and a third by the aristocratic mammals.

The reptiles have given us the turtles; the birds, the penguins; the mammals, the seals, sea-lions, and walruses.

In the first mentioned, all four limbs have been thrust into fingerless gloves; in the second only the fore-limbs or wings. In the mammals the hands and feet are gloved, so to speak, but the fingers remain distinct—not *separate*. They are united one to another by a sort of web.

These flightless birds then have much to tell us if we only read Nature's lessons aright. They make us think, and look about, and tell us much of the world around us that we had previously never suspected. They teach us to

be careful in drawing conclusions. We realise, indeed, that things are not always what they seem. That things which appear to be very much alike may in reality be very unlike. Thus a whale is not a fish because it lives in the sea, nor is a snake an eel, though the one may be hardly distinguishable from the other, and both may conceivably be caught in the same haul of the net.

The wing of the penguin is now, in consequence of this transformation to perform other duties, no longer a wing in function, but a paddle. If it were compared with a wing such as that of a pigeon or a duck, we should notice many superficial differences. First of all would be its great breadth, secondly we should find that we could not open and close it like other wings, but that it remained always open. Again, we should see it had no thumb, and lastly, we should miss the long distinct covert and quill feathers. Instead, we should find tiny feathers with very broad shafts, and very little of the vane or web which is found in all other birds. But, after all, these changes are but slight. The paddle is still a wing at bottom. It has only undergone a few comparatively slight and superficial changes to transform it into an efficient instrument for its new duties. Just as, by a few slight alterations, we can make some existing piece of machinery undertake new work without throwing the whole into the furnace to be recast.

Those who can visit the London Zoological Gardens should make their way to the fish-house at about the penguin's feeding-time. They will

then see what an admirable paddle his modified wing has become, having entirely supplanted the feet for the purpose of propulsion in the water. In the penguin, the feet are stretched out behind quite straight and held motionless, whilst the wings work as rapidly as if the bird were flying through the air.

Thus the loss of flight may be followed by the entire loss of the whole wing; or this organ whilst undergoing a certain amount of degeneration, may be saved, as it were, to perform some new function—such as that of swimming. The loss of the whole wing cannot be regarded as a dead loss to a flightless bird. The amount of nourishment which would be expended in its sustenance is put to the credit of the sustenance of the rest of the body.

CHAPTER VI.

COURTSHIP.

To tell the story of the courtship and lovemaking of the birds, in anything like fulness, would be to undertake a task far too large to be compressed within the limits of these pages. But we can and will take a brief survey of some of its more important features. We venture to think that these will form a surprise, as pleasing as it is great. That they will prove quite a revelation of the hidden life of the bird world.

With the birds, as with ourselves, there comes with the period of maturity, that strange indefin

able conviction, that it is not good to live alone, and all the energies become centred upon one object—the finding of a mate and the founding of a home.

The fashions, customs and traditions requisite, to be observed in bird society in securing this mate are as varied as in our own species. We may roughly divide the methods into conquest by blandishments, and conquest by battle.

Let us take conquest by blandishments first. These are of several kinds, though by no means sharply divided one from another. They may be classed under the heads of vocal and instrumental music, dances, antics and display of decorative or brilliantly-coloured plumage. In one or two cases it is hard to say whether we are dealing with a display of plumage, or an instance of battle.

The vocal and instrumental music of birds can be studied in Great Britain perhaps to better advantage than anywhere else in the world.

The glades and meadow-lanes of rural England teem with instances, as our literature, both poetry and prose, bears witness. Perhaps the skylark and the nightingale have secured the largest share of attention. Those who only know that divine songster, the skylark, as a prisoner, beating out its life against the bars of a tiny cage, can scarcely claim to have heard its song! Who does not feel raised to the seventh heaven of delight in listing to the nightingale trying, as it would seem, to "satiate the hungry dark with melody"?

The skylark, the nightingale, the black-cap,

and the thrush occupy undoubtedly the foremo
place amongst our English songsters. But th
are by no means the only minstrels we posse
Of songsters of lesser mark we have a crow
By describing them as of lesser mark we
not, however, wish to seem to despise the
On the contrary, we prize them scarcely le
than their more gifted brethren. They are t
life and soul of some of the fairest spots of o
riversides and hedgerows.

Our cousins beyond the seas are scarcely le
fortunate than ourselves. For our nightingal
they have the mocking-bird, the cat-bird, a
many more. How greatly, and how justly th
are esteemed, let their own poets—Walt Wh
man, Burroughs, Emerson and Longfellow
bear witness.

I would here say a few words with regard
the relation of the song of birds to our musi
which latter, as that great bird-lover, Mr Warc
Fowler, remarks, "is a highly-developed produ
of science and art combined: that you cann
write down on our musical scale without d
priving them of all that freedom and wildne
in which their very life and beauty consist; a
that they cannot be played upon a highly artist
instrument of man's making, though they can b
rudely imitated on a rude one. If they are
be compared with anything human, it shoul
rather be with that rude music of primitive ma
out of which our own has gradually been evolve
—with cries of victory, the wailing of wome
the weird chant of the prophetess, or even th
"hwyl" that may still occasionally be heard i

the Welsh pulpits." Nevertheless, our music has been and doubtless often is inspired by that of the birds. Thus, to quote Mr Warde Fowler again, "the song of the yellow hammer is said to have suggested the famous opening notes in Beethoven's symphony in C minor." Again, he tells us in the "andante of Beethoven's Pastoral Symphony, the voices of birds are consciously imitated." About the musical quality of these notes he asks, "In what sense can we truly call them music? what is their relation to our modern musical art?" The singing apparatus of a bird, he continues, "where it is perfect . . . is a legitimate musical instrument, consisting of a long tube and a tiny membrane which vibrates under the transmission of air from the lungs, and it is played upon, or modulated, by the muscles which tighten and relax like the lips of a performer on a reed instrument. The method of producing the sound is, in fact, very much the same in the bird and in a reed instrument, and this may account for what I may call the reedy quality of the voices of most birds."

In the oboe "the sound is produced by the reed affixed to the small end of the instrument, which vibrates between the lips of the player as he breathes air into it from his lungs." The vibration of the reed is "communicated to the column of air in the pipe of the oboe." The result is a true musical sound. The sound is produced in a similar way, by all songsters, and on the same principle as in the oboe. "The bird breathes from its lungs into two bronchial tubes; at the point where these two tubes com-

bine into one there is fixed a tiny elastic m
brane, which serves the same purpose as a r
and sets the air vibrating in the pipe w
corresponds to the pipe in the oboe, *i.e.*,
bird's windpipe. We are apt to fancy that
bird sings with his bill or his tongue, but
is altogether a mistake. . . . These may h
some kind of influence upon the sound, but t
sound is produced far down in the bird's throat
the thin end of the tube, just as it is in the ob
"In the oboe the tube is of wood, and th
fore hard and inelastic; of itself it cannot a
the pitch of the sound produced by it, but,
order to alter the pitch, holes have been punc
in the tube by stopping which with the fingers
can make the vibrating column of air in the t
longer or shorter at will, and thereby alter
pitch of the sound; just as in the trombo
the same thing is effected by moving one t
up and down within the other."

"In the bird's instrument the tube is not h
or stiff. . . . It can be lengthened and shorten
squeezed and relaxed, by many strong musc
which are attached to it; and these give the b
a capacity . . . of producing an almost endl
variety of pitch. . . ."

Many birds have exquisitely beautiful not
but they are nevertheless not to be confound
with song. Our English cuckoo, for instan
has no song. The well-known notes so dear
us all are to be regarded as call-notes intend
to give notice of his whereabouts to his ma
So again the piping of the curlew and ma
other water-birds are not songs, but call-not

Some others have deep trumpet-like notes which are used for a similar purpose. In some of these, as in certain swans and cranes, the keel of the breast-bone forms a hollow tunnel into which a part of the windpipe coils itself on its way to the lungs. In the painted snipe, curassows, the manucode, and some other birds, the windpipe is coiled many times between the skin and the muscles of the breast. In many ducks at the base of the windpipe there is a curious enlargement, forming a hollow chamber. It is generally supposed in such cases, that birds so modified have very powerful voices, or voices in some way peculiar. This does not however seem to be borne out by facts. In ducks, for instance, it is the female which has the loudest voice. The boom of the bittern again is a loud enough note yet the windpipe is in no way specially modified. In the female emu, the front of the windpipe, about half-way down the neck, opens into a curious bag, which, when filled with air, can be made to produce the curious drumming sound which this bird makes.

Certain other cries express danger signals, or it may be are intended as notes of defiance or challenges to battle.

Some birds sing in concert. Mr Hudson has vividly pictured for us such a concert, the performers being the crested screamer of South America. These birds, he tells us, often sing together in vast flocks at intervals during the night. He tells us how that on one occasion he was surprised by "an awful and overpowering burst of 'melody' which saluted him from half a

million of voices at an out-of-the-way spot in t
pampas one evening at nine o'clock; and ag
how once at noon he heard flock after flock ta
up their song round the entire circuit of a cert
lake, each flock waiting its turn to sing, and on
stopping when the duty had been performed."

The bird's voice then may express anger,
cognition or mate-hunting calls, or may breat
forth furious challenges, or soft-assurances of lo
but none of these need be included under t
category of true song. This brings us to t
question, what does the genuine songster mea
why does he sing? Opinions on this point a
by no means in strict harmony.

The most probable interpretation seems
be that the song, like that of the nightinga
for instance, is primarily for the purpose
winning a mate, and for her delectation duri
the period of incubation. It seems certain th
there exists a great deal of rivalry amongst t
males of each particular species in the neighbo
hood as to which shall sing best, the judges bei
the females of the same species settled near t
trial courts. These select the finest performe
and leave the rest to rise to greater proficien
—or remain bachelors. The fact that they si
before the pairing season actually begins, as w
as later in the year, need *not*, as some suppos
militate against this view. Neither does the fa
that a bird will sing immediately after its ne
has been plundered serve as hostile eviden
It may pour forth its soul in anguish as w
as in joy. We may not detect the difference
the two cases, but it may nevertheless be the

We would not rob our feathered friends of the credit of doing their best to show the world "how to be happy though married." When we find some songster, perched high above his mate, sitting on the eggs below, we can but feel that he is trying to charm the dull hours of waiting with his sweet-toned melodies. He is telling how that

> "The blue eggs in the robin's nest
> Will soon have wings, and beak, and breast,
> And flutter and fly away."

Some hold that singing is merely the expression of superabundant energy: that a bird sings from the pure enjoyment of life, and that the song is the measure of his superfluous vitality. They point to the fact that nearly all songsters are dull coloured, and that brilliantly-coloured birds rarely sing well. This may be true, but it need not affect the truth of the first hypothesis. According to this, brilliantly-coloured birds or great songsters represent those who have been so successful in the struggle for life, that they have something over of their vitality to spend in this way—the luxury of music, or fine feathers—but let it be noted, never both.

True song, then, is probably to be regarded as Darwin regarded it, primarily as a method of courtship. There is certainly great rivalry amongst the males as to who shall sing best, and it is probable that the female always chooses the finest performer as her mate. Call-notes, musical or otherwise, songs in concert, challenges and so forth, simply represent the language of the bird-world generally, and have

little or nothing to do with courting. It will
found that the birds which have no song for t
most part have adopted other means for t
purposes of courtship; it may be by antics,
may be battle. This is what is meant by sexu
selection. The preference of the female for t
finest performers gradually raises the standa
of the performance, in-as-much as the offspri
being begotten of parents with a higher æsthet
taste and degree of skill than the unsuccessf
suitors, would cause each generation to slow
improve upon the last. The excellence of the
performance to-day is the measure of the di
tance they have traversed from the dead lev
of mediocrity.

Of instrumental music we have not so ma
instances, nor are they so varied.

Our common British snipe (*Gallinago coelest*
affords us one of the best instances. In t
pairing season, and at this time only, it gives ri
to a most remarkable kind of noise, which h
been variously described as bleating, drummin
neighing or thundering, according to the ear
the listener. To the present writer it soun
rather like humming, like the noise often ma
by wind. Mr Darwin says, "This bird, duri
the pairing-season, flies to 'perhaps a thousa
feet in height,' and after zig-zagging about for
time, descends to the earth in a curved line wi
outspread tail and quivering pinions and surpri
ing velocity. The sound is emitted only duri
this rapid descent. No one was able to explain t
cause, until Herr Meeves observed that on ea
side of the tail the outer feathers are peculiar

formed, having a stiff, sabre-shaped shaft with the oblique barbs of unusual length, the outer webs being strongly bound together. He found that by blowing on these feathers, or by fastening them to a long thin stick and waving them rapidly through the air, he could reproduce the drumming noise made by the living bird. . . ." In some species four feathers and in others no less than eight on each side of the tail are greatly modified. The variation in the number and shape of these feathers give rise to a corresponding variation in the tone of the sound produced.

The guan, a South American game-bird, produces a similar sound with its wings. The late Mr Salvin says of it, "I well remember being startled by a strange sound when shooting in one of the ravines in the Volcan de Aqua in Guatemala. Not at first perceiving whence it arose, I walked on, when the noise was again repeated. I then set about discovering the cause and soon found that it was produced by a male *Penelopina nigra* (the black penelope) which, when flying in a downward direction with outstretched wings, gave forth a kind of crashing, rushing noise, which I likened at the time to the falling of a tree."

The manakins—small perching birds of South America—have the shafts of the secondaries, or quill-feathers of the forearm curiously "thickened to an extraordinary degree, forming a solid, horny lump." . . . These little birds make an extraordinary noise, the first "sharp note being not unlike the crack of a whip."

A very remarkable form of drumming is

practised by the kalij pheasant. Captain J. I Baldwin thus describes it: "We had been sittin motionless for, I suppose, half-an-hour, when was startled, all of a sudden, by the loud, drum ming noise . . . close at hand. The sound cam from behind, and on looking over my should my companion, with a smile, pointed out t drummer. An old cock kalij was squatting the stump of a fallen tree and, with all its feathe ruffled and tail spread, was causing this extr ordinary sound by rapidly beating its win against its body."

We will pass on now to the dances, antics a display of decorative plumage, and bare patch of coloured skin. Instances of this kind a very numerous, but a few of the more importa will suffice us here.

In the British Islands we have, or rather ha one magnificent example of these "love-antic or what is generally known as "showing-of Once upon a time, say two generations ago, the roamed on heaths and plains of England a lar bird—the largest of our British fauna—called t great bustard (*Otis tarda*). Cultivation of was land and improved fire-arms have, between the wiped out the bird from the list of our faun The last of the old British stock was killed Norfolk.

"When the male wishes to attract the att tion of the female bird," writes Dr Sharpe, " first approaches her with short steps, lifting feet from the ground and rustling his win His next proceeding is to throw his tail flat o on to his back, and to spread his shoulders o

so that, by crossing the ends of the long primary quills, he is enabled to keep the tail down, and he then ruffles up all his back feathers and scapulars, so as to completely hide the wings and the tail together. The white under-tail coverts are then brought up so as to form a kind of fringe or 'halo' at the back of the bird, who next proceeds to make an attempt to turn the feathers of the wing inside out. The white inner secondaries which lie nearest to the back are raised and thrown over the latter, and in order that there may be no mistake about these being seen, the bird flings down the long parapteral feathers which lie between the shoulders and the wing-coverts, and thus the wife is enabled to admire the show of white feathers which are elevated across the back. The wing-coverts are also treated in a similar fashion, but not quite to the same extent. Having accomplished this extraordinary contribution to the study of the love-making, the bustard then proceeds to inflate his chest, which he does by blowing out his pouch to an enormous extent; and then, burying his head in his neck so that his whiskers become upturned on each side of the head, he adds the final touch to one of the most wonderful exhibitions in nature. That *white* is an attractive colour in this display must be gathered from the extraordinary efforts put forth by the bird to show all his white plumage to the best advantage." What this display looks like is admirably shown on page 102.

The pouch referred to, and shown in the accompanying illustration (fig. 3), is a suffi-

ciently extraordinary structure to deserve a brie description here. It is a long thin-walled ba running all the way down the neck, just under th skin. Its upper end opens in front of, and belo the tongue, its lower end is often flask-shape enabling it the more easily, at the constricte portion, to pass between the merry-thought When the bird is "showing-off" this pouch i filled with air, and thus increases the size of th neck enormously. This pouch was believed b the older ornithologists to be for the purpose holding water, owing to the difficulty of pr curing this in the arid localities in which th birds lived. But as the pouch is only prese in the male the force of this argument was ha to see.

The display of the pinnated grouse (*Ty panuchus Americanus*) has been vividly describe as follows by Captain Bendire: "Early in th morning you may see them assemble in partie from a dozen to fifty together, on some high d knolls where the grass is short, and their goin on would make you laugh. The cock birds ha a loose patch of naked yellow skin on each side the neck just below the head, and above these on either side, just where the head joins the nec are a few long black feathers which ordinari lay backward on the neck, but which, wh excited, they can pitch straight forward. Th naked yellow patches . . . cover sacs which th can blow up like a bladder whenever th choose. These are their ornaments, which th display to the best advantage before the gent sex at these love-feasts. This they do by blow i

up these air-sacs till they both look like two ripe oranges on each side of the neck, projecting their long black ears right forward, ruffling up all the feathers of the body till they stand out straight, and dropping their wings on the ground like a turkey cock."

"Then it is that the proud cock, in order to complete his triumph, will rush forward at its best speed for two or three rods through the midst of the love-sick damsels, pouring out as he goes a booming noise, almost a hoarse roar, only more subdued, which may be heard for at least two miles in the still morning air. This heavy booming sound is by no means harsh or unpleasant, on the contrary it is soft and even harmonious. When standing in the open prairie at early dawn listening to hundreds of different voices, pitched on different keys, coming from every direction and from various distances, the listener is rather soothed than excited. If this sound is heavier than the deep keynotes of a large organ it is much softer, though vastly more powerful, and may be heard at a much greater distance. One who has heard such a concert can never mistake or forget it.

"Every few minutes this display is repeated. I have seen not only one, but more than twenty cocks going through this funny operation at once, but then they seem careful not to run against each other, for they have not yet got to the fighting-point. After a little while, the lady-birds begin to show an interest in the proceedings by moving about quickly a few yards at a time, and then standing still a short time."

"The party breaks up when the sun is half-an-hour high to be repeated the next morning and every morning for a week or two before all make

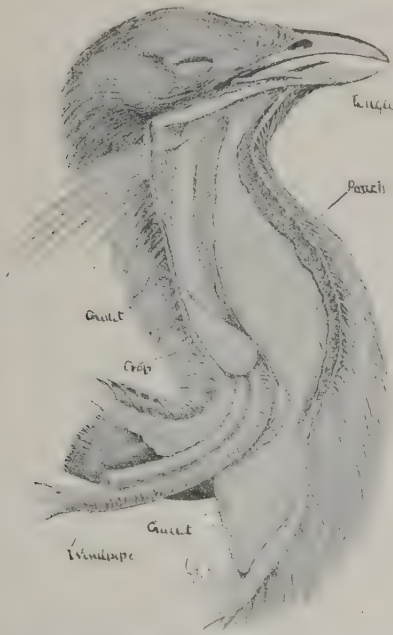

FIG. 3.—Dissection of the head and neck of a great bustard, *Otis tarda*, to show the curious wind-bag or pouch (p. 100) used in the love-display.

satisfactory matches. It is toward the latter part of the love-season that the fighting takes place among the cocks, probably by two who

have fallen in love with the same sweetheart whose modesty prevents her from selecting between them."

The pinnated grouse is not the only bird which has developed naked patches of coloured skin for the purposes of display.

The display of brilliantly-coloured plumage must be considered now. Of such exhibitions probably that of the peacock's "train" is most familiar, and must have been witnessed by many of my readers.

This train, it should be remarked, is *not*, as is popularly supposed, the *tail* of the peacock. It is made up of the feathers of the lower part of the back, and of the upper tail coverts. These gradually increase in length from before backwards, culminating in the long and exquisite feathers which form the circumference of the train. The real tail lies behind this and acts as a support.

These train feathers can be slowly and gently raised till the well-known fan-shaped glory of green and gold and blue is exposed to the fullest possible extent.

Watch the bird trying to do his best to persuade his chosen what a handsome fellow he is. He first places himself more or less in front of her, but at some little distance off; and then watching his opportunity, walks rapidly backwards, going faster and faster and faster till arrived within a foot, he suddenly, like a flash turns round and displays to the full his truly gorgeous vestments. This turning movement is accompanied by a violent shaking of the train

he quills of which rattle like the pattering of ain upon leaves. Often this movement is fol- owed by a loud scream.

When the train is fully erect it will be noticed hat it lies so far forward that the bird's head and eck appears as if rising from its base. In a side iew the whole body, from the front of the wings ackwards, appears to lie behind the train.

The curious part of it is, as in the case of the ustard and of the ruffs, the female appears to e supremely indifferent to all this fuss. Perhaps is etiquette to behave thus—to affect an in- ifference they do not feel.

The argus-pheasant, writes Mr Darwin, " . . . ffords a much more remarkable case. The mmensely developed secondary wing-feathers are ontined to the male, and each is ornamented rith a row of from twenty to twenty-three ocelli bove an inch in diameter. These feathers are lso elegantly marked with oblique stripes and ows of spots of a dark colour, like those on the kin of a tiger and leopard combined. These eautiful ornaments are hidden until the male hows himself off before the female. He then rects his tail, and expands his wing-feathers nto a great, almost upright, circular fan or ield, which is carried in front of the body. he neck and head are held on one side so that ey are concealed by the fan ; but the bird, in rder to see the female, before whom he is isplaying himself, sometimes pushes his head etween two of the long wing-feathers . . . nd then presents a grotesque appearance. This ust be a frequent habit with the bird in a state

of nature, for . . . on examining some perfe skins sent from the east [there was] found place between two of the feathers which w much frayed, as if the head had here frequent been pushed through.

"The ocelli on the wing-feathers are wonderf objects, for they are so shaded that, as the Duk of Argyll remarks, they stand out like balls lyi loosely within sockets. When I looked at t specimen in the British Museum, which mounted with the wings expanded and trailin downwards, I was, however, greatly disappointe for the ocelli appeared flat, or even concav But Mr Gould soon made the case clear to m for he held the feathers erect, in the position which they would naturally be displayed; a now, from the light shining on them from abov each ocellus at once resembled the ornamen called a ball and socket."

"The foregoing remarks relate to the secon ary wing-feathers, but the primary wi feathers, which in most gallinaceous birds a uniformly coloured, are in the argus-pheasa equally wonderful. They are of a soft brow tint, with numerous dark spots, each of whi consists of two or three black dots, wi a surrounding dark zone. But the chief orn ment is a space parallel to the dark-blue sha which in outline forms a perfect second feath lying within the true feather. This inner pa is coloured of a lighter chestnut, and is thick dotted with minute white points. . . . No these feathers are quite hidden on all ordina occasions, but are fully displayed, together wi

e long secondary feathers, when they are all panded together, so as to form the great fan shield. The case of the male argus-pheasant eminently interesting, because it affords good idence that the most refined beauty may serve a sexual charm, and for no other purpose. e must conclude that this is the case, as the condary and primary wing-feathers are not at displayed, and the ball-and-socket ornaments e not exhibited in full perfection until the ale assumes the attitude of courtship. The gus-pheasant does not possess brilliant colours, that his success in love appears to depend on e great size of his plumes, and on the elabora- n of the most elegant patterns. Many will clare that it is utterly incredible that a female rd should be able to appreciate fine shading d exquisite patterns. It is undoubtedly a rvellous fact that she should possess this most human degree of taste. He who thinks can safely gauge the discriminations and taste the lower animals may deny that the female gus-pheasant can appreciate such refined auty; but he will then be compelled to admit at the extraordinary attitude assumed by the ale during the act of courtship, by which the nderful beauty of his plumage is fully dis- ayed, are purposeless; and this is a conclusion ich I for one will never admit."

The birds of paradise again afford us striking stances of the recognition by birds of their n beauty.

Dr A. R. Wallace, during his stay in the Aru ands, was so fortunate as to witness one of the

"dancing-parties" of these birds. He sa
"The birds had now commenced what the peo
here call their 'sácaleli,' or dancing-parties,
certain trees in the forest . . . which had
immense head of spreading branches and la
but scattered leaves, giving a clear space for
birds to play and exhibit their plumes. On
of these trees a dozen or twenty full-plumag
male birds assemble together, raise up th
wings, stretch out their necks, and elevate th
exquisite plumes, keeping them in a contin
vibration. . . . Between whiles they fly acr
from branch to branch in great excitement.
that the whole tree is filled with waving plu
in every variety of attitude and motion .
the wings are raised vertically over the back,
head is bent down and stretched out, and
long plumes are raised up and expanded till th
form two magnificent golden fans striped w
deep red at the base, and fading off into the p
brown tint of the finely divided and so
waving points. The whole bird is then ov
shadowed by them, the crouching body, yel
head, and emerald-green throat forming but
foundation and setting to the golden glory wh
waves above. When seen in this attitude,
bird of paradise really deserves its name, a
must be ranked as one of the most beaut
and most wonderful of living things."

We might quote many another instance of
display of brilliant or decorative plumage,
space forbids.

We must now pass on to consider dances
playing-grounds.

The account of the display of the bird of aradise just related is regarded by the natives s a dancing-display ; we prefer to consider it ather as a dress-display.

The jacana of South America is an expert ancer. "Mr Hudson," writes Dr Sharpe, "says hat in the Argentine Republic he has seen these irds leave their feeding all in a moment, and vith quick excited notes cluster together in a lose group, and go through a singular and retty performance, all together holding their vings outstretched and agitated, some with a apid fluttering, others with a slow-moving, eisurely motion, like that of a butterfly sunning tself. The performance over, the birds peace-bly scatter again. . . ."

One, at least, of the manakins—small South American birds—practises the noble sport of ancing. Mr Nutting, in relating his travels n Nicaragua, writes: "The natives call this ird the 'bailador' or 'dancer,' but it was not ntil I had been in the region for some time hat I understood why it was called by that ame. One day when hunting through the lense forest, the profound silence was suddenly roken by the regularly repeated note of 'El Bailador,' and softly making my way to the pot, I witnessed one of the most remarkable erformances it has ever been my lot to see. Jpon a bare twig which overhung the trail at distance of about four feet from the ground, wo male 'bailadors' were engaged in a 'song nd dance' act that simply astonished me. The wo birds were about a foot and a half apart,

and were alternately jumping about two
in the air, and alighting exactly upon the
whence they jumped. The tune was as reg
as clockwork, one bird jumping up the ins
the other alighted, each bird accompany
himself to the tune of *To-lé-do—to-lé-do—to-lé*
sounding the syllable *to* as he crouched to spr
lé while in the air, and *do* as he alighted.
performance was kept up without intermis
for more than a minute, when the birds sudde
discovered that they had an audience, and m
off."

In the Hon. Walter Rothschild's "Avifaun
Laysan," there is a vivid word-picture of sim
antics of the stately albatross. "First, they st
face to face, then they begin nodding and bow
vigorously, then rub their bills together w
a whistling cry. After this they begin shak
their heads and snapping their bills with mar
lous rapidity, occasionally lifting one wi
straightening themselves out, and blowing
their breasts; then they put their bill under
wing or toss it in the air with a groaning scre
and walk round each other often for fift
minutes at a time."

Dr Sharpe, in his "Wonders of the B
World," gives the following extract from
Nelson's Report on the Birds of Alaska, illus
tive of the curious dancing habits of the cra
"On May 18, I lay in a hunting blind and
much amused by the performances of two cra
which alighted near by. The first-comer
mained alone but a short time, when a sec
bird came along, uttering his loud note at sh

ntervals, until he espied the bird on the ground, hen he made a slight circuit, and dropped close y. Both birds then joined in a series of loud olling cries in quick succession. Suddenly the ew-comer, which appeared to be a male, wheeled is back towards the female and made a low ow, his head nearly touching the ground, and ding by a quick leap into the air. Another irouette brought him facing his charmer, whom e greeted with a still deeper bow, his wings eanwhile hanging loosely by his side. She plied by an answering bow and hop, and then ch tried to outdo the other in a series of pasmodic hops and starts, mixed with a set of mically grave and ceremonious bows. The air stood for some moments bowing right and ft, when their legs appeared to become envious f the large share taken in the performance by ne neck, and then would ensue a series of skilled ops and skips, which are more like the steps of a urlesque minuet than anything else I can think f. Frequently others join, and the dance keeps p until all are exhausted."

Perhaps one of the most curious of all these nstances of dancing is that of the Cayenne lap-ing.

"These birds, which are known in the pampas y the name of teru-teru, generally live in pairs, nd have a curious habit of indulging frequently n a kind of dance or march, which is described y Mr W. H. Hudson. "This observer writes hat anyone watching a pair of these birds will ee an individual from another pair rise and fly o them. Advancing to receive their visitor, the

pair place themselves behind it; then all 'three' keeping step, begin a rapid, uttering resonant drumming note, in time with their movements the notes of the pair behind being emitted in a stream, like a drum-roll, while the leader utters loud single notes at regular intervals. The march ceases; the leader elevates his wings and stands erect and motionless, still uttering loud notes; while the other two, with puffed-out plumage and standing exactly abreast, stoop forward and downward until the tips of their beaks touch the ground, and sinking their rhythmical voices to a murmur, remain for some time in this posture. The performance is then over, and the visitor goes back to his own ground and may to receive a visitor himself later on."

The playing-grounds and gardens of some birds are perhaps even more remarkable than these instances of dancing. Those of the bower-birds are the most remarkable and have been graphicly described by Gould, the greatest of authorities on Australian birds.

One of the most remarkable is the bower of the "Gardener" bower-bird. This, says Professor Newton, shows an "appreciation of beauty perhaps unparalleled in the animal world." It builds, to quote the same author, "at the foot of a small tree a kind of hut or cabin . . . some two feet in height, roofed with orchid-stems that slope to the ground, regularly radiating from the central support, which is covered with a conical mass of moss, and sheltering a gallery round it. One side of this hut is left open and in front of it is arranged a bed of verdant

moss, bedecked with blossoms and berries of the brightest colours. As these ornaments wither they are removed to a heap behind the hut, and replaced by others that are fresh. The hut is circular, and some three feet in diameter, and the mossy lawn in front of it nearly twice that expanse. Each hut and garden are, it is believed, though not known, the work of a single pair of birds, or perhaps of the male only."

We have now come to the concluding section of this chapter—conquest by battle. In this form of courtship the male birds meet, sometimes in mortal combat, often, however, these battles seem to be rather like the tournaments of olden times wherein the "sterner" gather together to a mimic warfare in the presence of the "gentler sex" to win therefrom not only admiration, but a mate. In the real battle, the female is seized by the victor, in the mimic the male who wins most favour is chosen by the female. "Almost all male birds," writes Darwin, "are extremely pugnacious, using their beaks, wings and legs for fighting together." We see this every spring, with our robins and sparrows. The smallest of all birds, namely the humming-bird, is one of the most quarrelsome. Mr Gosse describes a battle in which a pair seized hold of each other's beaks, and whirled round and round till they almost fell to the ground; and M. Monte de Oca, in speaking of another genus of humming-bird, says, "that two males rarely meet without a fierce aërial encounter: when kept in cages 'their fighting has mostly ended in the splitting of the tongue of one of the two,

which then surely dies from being unable t
feed.' With waders, the males of the commo
water-hen (*Gallinula chloropus*) 'when pairing
fight violently for the females; they stan
nearly upright in the water and strike with thei
feet.' Two were seen to be thus engaged fo
half-an-hour, until one got hold of the head o
the other, which would have been killed, ha
not the observer interfered; the female all th
time looking on as a quiet spectator." An allie
bird (*Gallicrex cristatus*) is so "pugnacious durin
the breeding season that they are kept by th
natives of Eastern Bengal for the sake of fighting.

We in England can, or rather could, furnis
a splendid illustration of these battles, in th
"ruff" of our Fenlands. But, partly on accou
of the drainage of the ground which furnishe
it shelter and partly by reason of "its whol
sale capture in spring, for the tables of the ric
when 'game' is out of season," it must no
be regarded as extinct.

This bird is so called, writes Prof. Newto
"from the very beautiful and remarkable frill
elongated feathers that, just before the breedin
season, grow thickly round the neck of the mal
who is considerably larger than the fema
known as the reeve. In many respects th
species . . . is one of the most singular
existence. . . . The cock-bird, when out of h
nuptial attire, or, to use the fen-man's expressio
when he has not his 'show on,' and the hen
all seasons offer no very remarkable deviatio
from ordinary sand-pipers. . . . But wh
spring comes all is changed. In a surprising

short time the feathers clothing the face of the male are shed, and their place is taken by *papillæ* or small caruncles of bright yellow or pale pink. From each side of his head sprouts a tuft of stiff curled feathers (see frontispiece), giving the appearance of long ears; while the feathers of the throat change colour, and beneath and around it sprouts the frill or ruff already mentioned. The feathers which form this remarkable adornment, almost unique among birds, are like those of the 'ear tufts,' stiff and incurved at the end, but much longer—measuring more than two inches. They are closely arrayed, capable of depression or elevation, and form a shield to the front of the breast impenetrable by the bill of a rival. More extraordinary than this, from one point of view, is the great variety of colouration that obtains in these temporary outgrowths. It has often been said that no one ever saw two ruffs alike. That is perhaps an overstatement; but considering the really few colours that the birds exhibit, the variation is something marvellous, so that fifty examples or more may be compared without finding a very close resemblance between any two of them, while the individual variation is increased by the 'ear-tufts,' which generally differ in colour from the frill, and thus produce a combination of diversity. The colours range from deep black to pure white, passing through chestnut or bay, and many tints of brown or ash-grey, while the feathers are more or less closely barred with some darker shade, and the back is very frequently glossed with violet, blue or green—or, in addition,

spangled with white, grey, or gold colour . . every ruff in each successive year assumes tufts and frill exactly the same in colour and markings as those he wore in the preceding season; and thus, polymorphic as is the male, as a species as an individual, he is unchangeable in his wedding-garment."

"That all this wonderful 'show' is the consequence of the polygamous habit of the ruff can scarcely be doubted." Our really beautiful frontispiece gives a good idea of what this 'ruff' is like.

Their actions in fighting are said to be similar to those of the game-cock: the head is lowered and the beak held straight out; each particular feather is made to stand on end, the "ruff" and tail are extended to the full, so that the general effect is one of great ferocity. Then a swift movement is made by one or other of the combatants, the beak of the less active is seized and a leap made into the air, followed simultaneously by a stroke of the wing—generally a harmless one.

These combats take place on some slight eminence near the spot where the eggs are laid, the males meeting here for the purpose of contending for the females. This habit helped largely to bring about their extinction in this country. For the fowler, having discovered one of these spots of "hilling places" by the birds having trodden the spot bare, managed, by cunningly laid nets, to capture every bird that on the "hill."

Fighting would seem, however, to be one

a part of the methods of conquest practised by the ruff. He is also an adept in the art of "showing off." This, probably, is his plan of making himself agreeable to the ladies of his harem, or perhaps is intended to impress them with his beauty, and follows upon his conquest. That both "battle" and display or "showing off" are practised there can be no doubt, but there seems to be no record to show whether the fighting precedes or follows the "showing off."

Wolley, a well-known "light," in the ornithological word, now unhappily deceased, writes of the habits, or as Prof. Newton happily puts it the "moral characteristics" of the ruff:—

"The ruff, like other fine gentlemen, takes much more trouble with his courtship than with his duties as a husband. Whilst the reeves are sitting on their eggs, scattered about the swamps, he is to be seen far away flitting about in flocks, and on the ground dancing and sparring with his companions. Before they are confined to their nests, it is wonderful with what devotion the females are attended by their gay followers, who seem to be each trying to be more attentive than the rest. Nothing can be more expressive of humility and ardent love than some of the actions of the ruff. He throws himself prostrate on the ground, with every feather in his body standing up and quivering; but he seems as if he were afraid of coming too near his mistress. If she flies off, he starts up in an instant to arrive before her at the next place of alighting, and all his actions are full of life and spirit. But none

of his spirit is expended in care for his family. He never comes to see after an enemy."

"The males of almost all gallinaceous birds, even those which are not furnished with spurs, engage during the breeding-season in fierce conflicts. The capercailzie and black-cock . . which are both polygamists, have regular appointed places, where during many weeks they congregate in numbers to fight together and to display their charms before the females. Dr. W. Kovalevsky informs me that in Russia he has seen the snow all bloody on the Orenas where the capercailzie have fought; and the black-cocks 'make the feathers fly in every direction' when several 'engage in a battle royal.' The elder Brehm gives a curious account of the balz, as the love-dances and love-songs of the black-cock are called in Germany. The bird utters almost continuously the strangest noises; 'he holds his tail up and spreads it out like a fan, he lifts up his head and neck with all the feathers erect, and stretches his wings from the body. Then he takes a few jumps in different directions, sometimes in a circle, and presses the under part of his beak so hard against the ground that the chin feathers are rubbed off. During these movements he beats his wings and turns round and round. The more ardent he grows, the more lively he becomes, until at last the bird appears like a frantic creature. At such times the black-cocks are so absorbed that they become almost blind and deaf, but less so than the capercailzie: hence, bird after bird may be shot on the same spot, or even caught by the

hand. After performing these antics the males begin to fight, and the same black-cock, in order to prove his strength over several antagonists, will visit in the course of one morning several balz places, which remain the same during successive years."

Many of the game-birds have the legs armed with powerful spurs. These are capable of inflicting terrible damage; as witness the records of the old days of cock-fighting. In these cases, however, their power as weapons of offence was increased by fastening silver sheaths on to the natural spurs. The blood-pheasants are the most heavily armed, having from four to five pairs of spurs on each leg. So pugnacious is the disposition of this group of birds, that they fight not only for the possession of the females, but on the slightest provocation, and frequently on none at all. Thus, Mr Frederic Wilson writes of the kalij-pheasant that "it is very pugnacious, and the males have frequent battles. On one occasion I had shot a male, which lay fluttering on the ground in its death struggles, when another rushed out of the jungle and attacked it with the greatest fury. . . ."

Some birds there are which have the spurs upon the wings instead of the legs. Many of the plovers, *Hoplopterus*, the Egyptian spur-winged plover for instance, has large and very sharp spurs. In Egypt these birds have been seen to fight, after the manner of our common English peewit, by turning suddenly in the air and striking with the wings. In the case of the Egyptian bird the result is often fatal. With

our plover this is rarely or never the case there being only swollen knobs in the place of spurs. Two very rare and ancient forms of geese, known as the chauna, and the horned screamer of South America, have the wings armed with huge spurs. So also does the African spur-winged goose, *Plectropterus*. These spurs it should be mentioned, are bony outgrowths capped with horn, seated on the wrist bones, or the metacarpal bones, and are quite distinct from claws with which they are often confounded.

CHAPTER VII.

FAMILY CARES—BUILDING THE HOME.

With the birds, as with ourselves, during the period of courtship, more or less public protestations of affection, undying devotion, and fidelity are freely made, but like cheques we can only prove their genuineness at a later date.

The pure, sweet, full-throated songster proves himself, when the time of trial comes, to be in every way equal to the highest that could be expected of him. Of one who sings so sweetly we look for great things. With silver-tongued melody he wins his mate, and with the same charm he soothes her during the period of incubation; but when called upon to face the sterner work of life in providing food for some five or six ever-hungry mouths he puts away his music and joins his mate in satisfying their

wants. How considerable these are, we shall see later. How different is the case with the buffoonery, and bluster, or brute force of the ruffs, the bustards and the game-birds. Here, no sooner has their wooing proved successful, than they turn their backs upon the females and leave them to fend as best they may, roaming the country it may be in parties as in bachelor days, or flitting indolently about the neighbourhood in wanton idleness. Fortunately, there is not much need of their help, for the young are able almost at once to run and feed themselves. But of this anon.

We have seen something of our feathered friends during the period of courtship, we are now going to take a peep at them in the homes which they have newly founded. The choice of a mate having been made the next step is to select a site on which to build a home. This home we call a "nest." The form which this nest may take, and the situation of the site, are exceedingly variable, though always constant in each kind of bird.

The object of a nest is to contain the eggs, and often the young, so that such a structure need not possess great durability, being required only for a few weeks in the year. It is not used, as is sometimes supposed, for the nightly shelter throughout the year.

The range of variation in the site chosen and in the form of the nest, is, as we shall see, a very wide one. We shall find it, in its rudest form, as a simple hole scraped in the ground, and in its highest, amongst the most elaborate and

beautiful structures in the animal world. W shall find it placed on the ground, in burrow in hollow trees and in caverns, on the wate in our hedgerows and bushes, in lofty trees, an on ledges of the most precipitous cliffs. Whe ever and wherever the nest is found its ever detail should be carefully studied, for muc mystery still enwraps it.

Of the most primitive are the ground-builder such as the little ringed plovers and terns of th flat sandy beaches of our islands. Mere hollow in the sand, these "nests" would most certainl escape detection but for the chance discovery o the treasures they contain—the eggs. We sa chance discovery advisedly for these eggs s closely resemble the surrounding shingle tha they are almost impossible of detection save b the most experienced.

The ostriches and coursers of Africa and India and the pratincoles of South Europe, India an Australia, likewise deposit the eggs in a sligh depression in the ground.

The tinamous of South America, the penguins many plovers and gulls make a slight depressio in the ground and give it a scanty lining of grass The ducks line a similar depression with dow plucked from their own breasts, and so on.

Many birds seem to have found the pre paration of making even a slight hollow to much trouble, or perhaps, unnecessary, an deposit their eggs on the bare ground withou any further preparation whatsoever. The diver thick-knees, sand-grouse and night-jars, are in stances of this. The auks and guillemots agai

build no nest but deposit their eggs on the bare edges of rocks which go to make the cliffs around our coasts. In these birds the form of the egg is specially modified on account of this habit. Their shape is roughly pear-shaped, so that, when blown by the wind, the egg revolves round on its small end, instead of rolling off into the sea below. As it is, many thousands *do* meet this fate every year. It used to be a favourite sport of wretches armed with guns to fire a shot from the top of the cliffs on which these birds nested, so as to startle the sitting-birds, and cause them, as they hurriedly left their eggs, to knock them off their ledges *in thousands* into the sea, in order that they might afford sport, or gratify the hideously morbid curiosity of tourists.

In all the cases which we have considered, in which birds make little or no provision for their eggs in the shape of a nest, but leave them fully exposed to view, it will be noted that these, for the most part, so closely resemble surrounding objects as to make further attempt at concealment unnecessary. It is almost certain that originally all birds laid white eggs, as do their cousins germane the reptiles. But as there is at least one reptile in which there is a distinct tendency to produce a coloured, rust-spotted shell, viz., the Tautera-lizard of New Zealand, so there may have been many birds in which the same tendency developed itself. Of these many would produce eggs much more strongly marked or spotted than their neighbour's. If a number of such birds migrated, say, from the forest-land of their ancestors to the plains or meadows, a process of

weeding out would quickly begin. For the would probably at once come in contact wit new creatures, who would rapidly discover hov good eggs were. Thus, those which were eve slightly coloured would be in so far disguise Having a taste for *white* eggs their enemies woul pass the coloured so long as white were to b had. In this way white eggs would become mor and more rare, for in course of time the birdi which produced these would die, and die withou leaving offspring, or so few that they would b swamped by inter-crossing with the newer an more vigorous race who had succeeded in layin coloured eggs. Some of these, unsuccessful i producing coloured eggs, learnt the lesson of re peated robberies, and sought crevices in rocks or unoccupied burrows in the ground—them selves undertaking the work of excavating whe necessary—and they have survived, and the children make their homes in holes in rocks an burrows in the ground to this day. A proces precisely similar to that just sketched out wa going on at the same time in the forests. Egg here would soon have become a delicacy, and th same mode of disguise almost certainly occur ring, the resultant protection would soon follow Those who failed to produce coloured eggs, an yet survived, were those who sought safety i the hollow trees always at hand.

First of all, let us take a few cases of thos birds who lay their eggs in burrows and holes i the ground, making little or no provision for ther in the shape of a nest.

In the British Islands to begin with we hav

some excellent examples. One of the most familiar must be the tiny tunnels driven by the score into the faces of sandy railway banks and cliffs by the Sand Martin. It seems almost impossible that these can have been tunnelled out by so small a bird, and when we examine the frailty of its beak and feet the mystery is deepened. The tunnels which they bore are of considerable length; at the end they expand slightly and herein is placed an apology for a nest, consisting of a few roots and feathers pressed closely together.

The sheldrake, one of the most beautiful of our ducks, builds its nest in burrows, usually those deserted by rabbits. The nest is sometimes as much as ten feet from the entrance and formed of bents of grass and gradually lined with down plucked from its own breast; the quality of this down is said to be but little inferior to eider-down. The puffin (*Fratercula arctica*) breeds in burrows, which it sometimes excavates for itself. If empty rabbit-burrows are to be had, the birds take these and save themselves further trouble; if still occupied by rabbits the latter are promptly evicted. Many of the petrels lay their eggs in rabbit-burrows. The kingfisher (*Alcedo ispida*) also breeds in burrows, generally those deserted by the water-vole. At the far end of the burrow an enlargement is made, the floor of which is quickly covered with a mass of fish-bones, and the hard parts of the external skeletons of such crustacea as may have been captured in the neighbouring streams and pools. These fish-bones and other materials are the undigested

parts of the bird's food which are ejecte again through the mouth, exactly as are th pellets of the owls and hawks. On this mass o bones the eggs are laid. There is a traditio still extant that the authorities of the Britis Museum were so anxious to secure a perfe example of this peculiar nest that they we willing to pay as much as £100 for a specime Offers of such imaginary treasures are constantl being made to this institution.

From burrowers in the ground we pass to bu rowers in the trees.

The most notable of these is the woodpecke The British Islands possess several differe species, but the great stronghold of these bird is America.

The woodpecker is a much maligned bird being accused of destroying forest-trees b driving tunnels or burrows into the trunk an so admitting the wet. As a matter of fact thi is a perfectly unjust accusation. The bird always choose a weak spot upon which t operate, one from which the life has alread been sapped by fungi. Wherever such parasite grow, they kill the wood. The mischief, how ever, is not apparent to any but the trained ey of this master of forestry—the woodpecker. H seizes upon these weak spots as "desirable site for building purposes," the wood being soft, an yielding readily to the blows of his powerful beak No nest is made, the eggs being laid upon th smaller chips which fall to the bottom of th hole during the process of excavation.

It might be mentioned here that in the wood

pecker we have another example of the adaptation and specialisation of parts. We have seen already how peculiarly the tongue has changed, we turn now to the tail-feathers. These differ from those of all other birds in their peculiar stiffness. They have been modified to form long sharp-pointed supporting rods, the tips of which the bird forces against the trunk of the tree to serve as a lever when driving his powerful pick-axe into the bark, or as an additional support in making vertical ascents. They may be regarded in short as climbing-spurs.

The little nut-hatches of our woodlands are also breeders in holes in trees. If the aperture is too large they plaster it up with mud till it is reduced to the required size: generally this is so small that the birds have to wriggle themselves in and out.

The hornbills of Africa, India, and the Malay Archipelago, are amongst the most remarkable of birds in their nesting habits. Having selected a hollow tree, the female takes up her station therein and remains incarcerated for many weeks. The following account of the nesting habits of the Bornean rhinoceros hornbill has been recently given by Mr Hose. "The nest," he says, "is always built in the hollow of a large tree—the hollow, be it noted, being always due to disease of the tree or to the ravages of termites, not to the personal labours of the birds. The bottom of this cavity is often plugged by a termite-nest and accumulation of decayed wood, and on the upper surface of this is made the nest, a very rough-and-ready struc-

ture, composed simply of the feathers of th female. The hollow of the tree communicate with the exterior air by means of a long apertur which, just before the period of incubation, closed up almost entirely by the male, simpl leaving a long slit open, up and down whic the beak of the enclosed female can move. Th substance used in thus closing the apertu closely resembles some vegetable resin, and probably composed of a gastric secretion com bined with the woody fragments of fruit. should be noted that this slit is always in clos proximity to the nest, so that the female ca easily protude her beak for food without movi from her sitting-position. During incubation th male bird supplies the female with food in th form of pellets of fruit, seeds, insects, portion of reptiles, etc., the pellets being enclosed eac in a skin of rubber-like consistency. Whi feeding the female, the male clings to the bar of the tree, or sits on a branch if convenientl near, and jerks these pellets into the gapin beak of the hen, two to four pellets formi a meal. During mastication (for it is a mistak to suppose that the hornbills always bolt the food entire) some fragments of the pellet fa to the ground; any seeds which these fragmen may contain take root, germinate, and sprou and the natives can judge approximately of th date of incubation by the age of the seedling When these are four-leaved, the eggs have bee hatched out for two or three weeks. At th stage, though not always so early, the mothe bird leaves the nest, breaking down the glue

substance with her beak to effect an exit; having left the nest, the aperture through which she left is carefully closed up again, leaving the slit as before, and now both male and female devote their energies to feeding the young birds, who in course of time follow the example of their mother and leave their place of imprisonment. It is more than probable that this glueing up first of the mother-bird and her eggs and afterwards of the nestlings alone is solely a means of protection against predaceous carnivora. . . ."

"The nesting season is during May and June, and it is noteworthy that the birds, if undisturbed, return to the same nesting-place every year. The saplings at the foot of the tree, sprung from seeds dropped in the first year of pairing, afford signs to the natives of the number of years during which the tree has been occupied. If during pairing or incubation the female, or female and young are destroyed, the male takes to himself another mate, and repairs to the same nesting-place; if, however, the male and female are destroyed, the nest is never re-occupied by other pairs. An interesting incident was observed while on Mount Dulit. Espying on a tree the external signs of a hornbill's nest, and a male *Buceros rhinoceros* perched close by, I shot the male, and while waiting for my Dyak collectors to make a ladder up the tree to secure the female, I observed several young male birds fly to the nest, and assiduously ply the bereaved widow with food, a fact which seems to indicate a competition in the matrimonial market of the bird-world as severe as that among human beings. It is no

easy matter to procure embryos or nestlings
hornbills, for the natives are inordinately for
of both as articles of diet; and, further, are alwa
anxious to secure the tail-feathers of the adul
to adorn their war-coats and hats. The nati
method of catching the female during incubatio
is ingenious, though decidedly brutal. The tr
is scaled, the resin-like substance is broken awa
and the frightened bird flies from her nest up t
hollow trunk of the tree, but is ignominious
brought down by means of a thorny stick (t
thorns point downwards), which is thrust aft
and twisted about until a firm grip in her pluma
and flesh is obtained. The Dyaks, never ve
faithful observers of nature, believe that t
female is shut up by the male, so that aft
hatching out her eggs, she may die, the maggo
in her putrefying body affording food for t
young. One very curious habit of *Bucer
rhinoceros*, which I have not hitherto seen note
is the rapid jumping up and down on a bran
with both feet together. This jumping moti
is imitated by the Kyans and Dyaks in the
dances, the figure being known to the Kyans
'wan blingong.'"

The reason for this strange incarceration
perhaps traceable to the fact that it occu
during the period of greatest helplessness: wh
the bird is moulting, and it would seem incapab
of flight. Walled-in on every side, with on
a small aperture for the beak, she is secure
protected from enemies of all kinds — exce
man.

The bag enclosing the food brought by t

nale is, strange to say, the lining membrane of
is own gizzard which is ejected together with
ts contents!

As Dr Sharpe remarks, "between providing
naterial for the effectual imprisonment of his
vife, and shedding the lining of his gizzard for
ier future sustenance, to say nothing of that of
he baby, the male hornhill must have rather a
ad time of it. No wonder then that Livingstone
ays that the prisoner becomes quite fat, and
s esteemed a dainty morsel by the natives;
while the poor slave of a husband gets so lean,
hat in the sudden lowering of the temperature,
which often happens after a fall of rain, he is
benumbed, falls down, and dies."

We will next turn to birds which build
nests of mud, mixing a certain amount of
saliva therewith to ensure durability. We
have two very perfect examples of such mud-
built nests, amongst those of our British birds.
The house-martin (*Chelidon urbica*) and the
swallow (*Hirundo rustica*).

The beautiful cup-shaped nest of the house-
martin must be familiar to most of us. It is
made of mud gathered from rain-pools by the
roadside or the riverside, and carried bit by bit
in, and ejected from the mouth of the little
architect, on to the surface of the selected site.
As soon as a sufficient foothold can be obtained
on the foundation of the new house, one or other
of the little builders works continually from the
inside to direct its shape. The pertinacity with
which these poor birds will adhere to any spot
they have selected is amazing. The writer well

remembers two misguided pairs who decided
throw themselves on the generosity and mer
of the powers that were, for the time bein
and that was some four years ago, at a certa
College in Oxford. They elected to build und
the archway of the main entrance. No soon
had they completed their nest than it w
ruthlessly swept away by the College servan
Again they tried with the same result; nothi
daunted, they tried yet a third time with t
same result; before the fourth nest was complet
the writer sought out one of the dons a
pleaded for his feathered friends. But, alas!
spite of every argument, and every suggesti
for lessening any possible inconvenience whi
might accrue from their presence, he was t
that it was in vain to plead. "We cannot ha
swallows' nests under a College Archway," w
the final pronouncement. For three consecuti
years these birds, or apparently the same,
turned to this much coveted spot, and spent t
summer fretting out their little lives in a v
appeal for mercy where mercy was not.

In Lapland, these birds are always welcom
In Muonioniska in 1853, Wolley, the gre
naturalist, counted nearly one hundred a
seventy nests round the courtyard of one hou
"In Lapland the people almost everywhe
multiply their eaves by nailing narrow plan
to the walls at such a distance that there is ju
room between them for the nests, which th
appear row under row." . . . The cause of t
bird's abundance in the country, and of the
commodation so gladly given to it, can be read

understood when one sees and feels the innumerable gnats.

The saucer-shaped nest of the swallow is as familiar an object in our rural homesteads as the cup-shaped structure of the martin. Like these, it is built of little pellets of mud, tempered with saliva. But, whilst the martin's nest is self-supported, the swallow's is always deposited on a beam or rafter, and has small pieces of straw and grass intermixed with the mud. The Indian fairy-martin builds a very beautiful retort-shaped mud-nest; it is like a flask, fixed by its base to the wall, with a long neck forming the mouth of the nest, projecting some eight or nine inches outwards. These curious nests are found in India, Africa, North America and Australia. The nest of the Australian cliff-swallow, or fairy-martin, is said to be made by the united efforts of several birds, one remaining inside the nest and receiving the pellets as they are brought by its companions.

Some of the strangest nests are those of the edible swiftlets. These birds have increased the power of secreting saliva to so great an extent that mud and other foreign matter is almost or even entirely suppressed, the nest being made of the pure secretion. Such are in great demand amongst the Chinese, for conversion into "bird's-nest soup."

"With these nests," writes Dr Sharpe, "a large trade is done with China from many of the Malayan Islands, over three and a half million nests having been known to be exported in a single year from Borneo to the latter country, where bird's-nest soup is considered a delicacy.

In Borneo and other places the caves in whic
the swiftlets build are leased to the collectors fo
a considerable sum, but it is only the white nest
made of the pure secretion derived from th
salivary glands of the birds which are of an
real value. Quantities of guano are also foun
in some of the caves, formed by the *débris* fro
the nests. The bodies of young birds which hav
perished, and the droppings of hundreds of o
cupants, form together a loathsome mass o
putrid water, reaching in a cave visited b
Colonel Legge in Ceylon to a depth of 30 fee
Mr Harry Pryer found that in one of the grea
caves of northern Borneo a pole thrust into th
guano to a distance of 18 feet did not reach th
bottom, and there was over the floor an averag
accumulation varying from 5 to 15 feet, so tha
it is evident that the caves inhabited by th
swiftlets must have been tenanted by these bird
for a very long period."

Yet another swift's nest must be noticed her
"One of the most curious nests in the world
writes Dr Sharpe, in his oft-quoted "Wonders o
the Bird-World," "is to be seen in the bird-galler
at the Natural History Museum, and is the wor
of Salvin's Swift (*Panytila sancti-hieronymi*) fro
Guatemala. It is entirely composed of seed
but whether the bird gathers these from th
plants or catches them in the air as they a
blown by the wind, has not been observed. I
this way the scanty material for the nest of ou
European swifts (*Apus apus* and *A. melba*) a
obtained, but in the Guatemalan species the ne
is of such huge size that it would take a ver

long time or the co-operation of many pairs of birds to collect the seeds in full flight. The nest was found by Mr Osbert Salvin in 1858, hanging under a shelf of rock, to which it was attached by means of the bird's own saliva, which is also employed throughout the building of the nest, to cement the seeds together. As with the penduline-tits . . . the nest of this swift also had a false entrance at the side, which Mr Salvin considered might 'be placed there to deceive some enemy, such as snake or lizard, to the attacks of which the parent-bird and its offspring would, during the time of incubation, be more exposed.'"

We have yet three more mud-nests which must be briefly noticed here—the nests of the flamingo, the oil-bird and the oven-bird.

The flamingo is an aberrant stork: the only one of all his house who builds a mud-nest. This is but a huge pile of mud raised a few inches above the water, by which it is generally surrounded. The long legs of this bird, like those of the heron, are doubled up under the body when sitting. There was an old idea that both these birds sat "straddle-legs" across the nest. Needless to say such a notion is ridiculous, for the birds can as easily fold up their legs as can the sparrow for instance.

The oil-bird, or guacharo, is a kind of night-jar common in Peru. It builds a mud-nest in a cave. The hard indigestible seeds investing the fruit upon which this bird feeds "are found," says Prof. Newton, "in quantities on the floor and the ledges of the caverns it frequents, where many of them for a time vegetate, the plants thus

growing being etiolated from want of light . . forming a singular feature of the gloomy scene which these places present. . . . The young [guachoros] soon after they are hatched become a perfect mass of fat, and while yet in the nest are sought by the Indians, who, at Caripé . . . make a special business of taking them and extracting the oil they contain. This is done about mid-summer, when by the aid of torches and long poles many thousands of the young birds are slaughtered, while the parents in alarm and rage hover over the destroyers' heads, uttering harsh and deafening cries. The grease is melted over fires kindled at the cavern's mouth, run into earthen pots, and preserved for use in working as well as for the lighting of lamps. It is said to be pure and limpid, free from any disagreeable taste or smell, and capable of being kept for a year without turning rancid. In Trinidad the young are esteemed a great delicacy for the table by many, though some persons object to their peculiar scent, which . . . resembles that of a cockroach. . . ." For a tale of horror and satanic treatment, this slaughter of the innocents accompanied by the helpless wailing of the bereaved parents would be hard to beat.

The last of our mud-builders is that of the oven-bird of South America. The nest of this bird certainly merits the term "wonderful," which has often been accorded it. Placed in a most conspicuous position—the tip of a post or bare bough of a tree,—it is a very massive structure,—weighing as much as eight or nine pounds, and is composed of mud and

pieces of sticks and straw. In shape it somewhat resembles a squat bee-hive, or, as some say, an oven. The opening into this hive is large; inside, it is divided by a partition reaching nearly to the roof, and forming a passage or ante-chamber to the large chamber containing the eggs which are laid upon a bed of soft dry grass. We cannot but be struck with the industry and labour which must be expended in the construction of so large a nest, by so small a bird. The collection of the mud alone must impress us, when we recollect that the workman has nothing but a tiny beak to carry it in, so that it must be carried a pellet at a time, and a small pellet too!

We must now turn our attention to nests of a more complex character than any yet examined. They are made up of small blades of grass, roots, leaves, or sticks, they are sometimes objects of rare beauty, sometimes little more than slovenly piles of sticks, etc. The sites chosen for these vary as greatly as do the nests themselves. They occur on the ground, in thickets, or on the tops of the highest trees. Some rest upon branches, some are swung in the most perfect manner, hammock-wise *beneath* the boughs. Some are gems of the most exquisite beauty, some loosely made and untidy in the extreme; some are open to the sky; some domed; some hang like retorts, mouth downwards. It will be impossible to do more than take a hasty survey of some of the most important of them in this little work.

These nests are of the same kind as those

which we considered in the opening part of thi
chapter, only much more perfectly made. W
have now something more than a mere collectio
of bits of grass, and roots, and so forth, used a
a lining to some slight hollow in the groun
or for the floor of the terminal chamber of som
tunnel or burrow. These which we are no
about to examine are deftly interwoven stru
tures capable of standing a considerable amou
of wear and tear.

Among the simplest are those of the dove
and pigeons, made of small branches and twig
of trees. The nest of one of these—the woo
pigeon for instance—is nothing more than
platform of sticks, so loosely put together th
the eggs can be seen through it against the sk
when the nest is viewed from below. Th
rooks and herons are British birds which buil
comparatively simple nests: an advance, how
ever, upon those of the doves, as the centre o
the structure is more or less carefully lined wit
fine grass, fibre, wool, and so on, for the recep
tion of the eggs.

In strong contrast to these harsh nests o
sticks stand the exquisitely beautiful nests o
the goldfinch and chaffinch. The latter is con
structed for the most part of wool and hai
matted together so as to form a very perfec
"felt." On the outside of this are fastened, o
rather woven, mosses, lichens, and spider-web
The whole so completely harmonizes with it
general surroundings as to make it very difficu
of detection.

The nest of the British reed-warbler is on

of very great beauty. It must be sought for in our reed-beds, or the banks of such of our rivers as are liberally fringed with reeds. The stems of some three or four reeds are utilised as supporting pillars, and between them the nest is built so that, when finished it looks as though the reed-stems had been driven through its sides. The materials of which the nest is constructed are the seed-tufts, long grasses, moss, and portions of reed-leaves. It is lined with cow's hair. The cavity of the nest is very deep, so that even when the pliant reeds are bent nearly level with the water the eggs yet remain safe inside.

Whilst the nest of the reed-warbler is supported by branches passing *vertically* through it, that of the golden oriole is peculiar in that the supporting branches pass *horizontally* through its sides. It is composed of sheeps' wool, fibres of roots, slender grasses, and so on; all perfectly interwoven. All these are cup- or saucer-shaped nests.

That of the dipper is peculiar, as much on account of the site which is chosen as for its shape. The nest is a large mass of finely felted moss, in the middle of which the eggs are deposited. It is built, almost invariably *behind* some cascade, so that the birds have to pass *through* this torrent of water every time they enter or leave the nest. ". . . in some places, particularly in Scotland, where this bird is known as the water-cow, water-pyet, and kingfisher, it is foolishly destroyed by every possible device under the mistaken idea that it haunts

the spawning-beds to feed on the ova of th salmon and trout, while examination of it gizzard proves it to be one of the best guardian of the fishery." Alas! another victim to be adde to the already long list of slaughtered innocents.

So far, the nests we have considered, whe built above the ground, have all rested *upo* some support, and have been more or les cup-shaped; or have been formed of sticks into platform more or less hollowed in the middl That of the dipper was an exception, bein domed, concerning which form more has to b said. We come now to pensile nests, nest slung or suspended *beneath* instead of *above* th bough, or other support, and will take a glanc at one or two of the more important.

The first, and one of the most wonderful o them is that of the tailor-bird. Choosing tw long leaves at the end of a twig, it bores a serie of holes down the outer side of each, then wit some long thread of vegetable fibre proceeds t seam the two leaves together by passing th thread through and through with its beak, much a we should do with a needle. In this, it is probabl assisted by its mate who would look from th inside and push out the threads as they cam through. The cavity of the nest is lined with a kind of cotton-wool, and in this are deposited th eggs.

The smallest of our British birds, the golden crested wren, builds a most elegant pensile bu cup-shaped nest. It is built of the "softes moss, thickly felted with wool and spiders' webs intermixed with a few grasses and dead leaves

and is lined with a quantity of small feathers." Macgillivray, the great ornithologist, by the way, once took the trouble to count up the feathers in the nest of a long-tailed tit, and found more than 2000. One can best appreciate the amount of labour this represents by recollecting that probably every one of these feathers was captured and brought in singly.

The nests of the baya-sparrow of India, and of the penduline-tits differ markedly from the normal form of cup-shaped nests so familiar to us all.

That of the baya-sparrow is suspended from the branch of a date palm, or cocoa-nut tree, or, it would seem in Burma, from the eaves of bungalows. "Its shape," says Prof. Newton, "can best be likened to a stocking hung up by the toe with the 'heel' enlarged to receive the eggs, while access and exit are obtained through the leg." In constructing the nest, the male and female are both engaged. The male, seizing a long piece of grass, thrusts it into the fabric already made; the female inside pulls it through, and then passes it out to him again, so that a very strongly plaited structure is the result.

The male bird, it seems, cuts his own grass, and this he does from the long blades of the seenta grass in the following manner. Alighting on the leaf head-downwards, "he bites through the edge to the exact thickness which it requires. He then goes higher up on the same blade of grass, and, having considered the length needed, bites through it again. He then seizes it firmly at the first notch and flies away. Of course the

strip of grass tears off and stops at the notch
He then flies away with the grass streamin
behind him. As the edge of the grass is muc
serrated, the bird has to consider and pass i
through the right way."

The nests of the penduline-tit or cotton-bir
of South Africa, Dr Sharpe remarks, "are s
extraordinary that they could hardly be believe
to be the work of a bird at all. On handlin
one of their nests it feels as if it were made o
the finest felt carpet, and how the birds contriv
to weave it out of cotton and seed-down is
mystery. Towards the upper end of the nes
is a funnel-shaped opening, and below this i
a distinct little pocket, the use of which is nc
clearly understood, though . . . it is suppose
to be a roosting-place for the male, for whon
as the nestlings grow larger, there would b
no room in the nest itself. The little birds
are said to draw in the tubular entrance of th
nest before they finally go to sleep, and the
then fasten it up tightly, so that any enemy
snake or otherwise, on attacking the nest, fumble
about at the pocket or false entrance, while th
little birds peck a hole in the back part an
escape."

Birds, for the most part, become very secret
ive concerning their nests. When not altogethe
hidden from view these are placed high up out o
reach, or on the faces of precipitous cliffs, and
so are inaccessible. Sometimes, however, n
attempt at isolation or concealment is made
and the birds breed in colonies. Examples o
such are furnished amongst British birds by

ur "rookeries" and heronries, for instance; and y the wonderful gull colony at Scoulton Mere, Norfolk, where the black-headed gull breeds in housands; as also by the guillemots and gannets long our coast-line, and so on. The penguins, lbatrosses and terns, swifts, swallows and martins, re other, and well-known cases. In all these, nowever, the nests are separate one from another.

The nesting-colonies of the sooty terns or 'wide-awakes" are peculiarly interesting. Dr Sharpe tells us that this bird "herds in countless numbers on Ascension Island," and "wide-awake fair," as the nesting-place is called, has often been alluded to in works on ornithology. One of the best accounts is that given by the late Commander Sperling, who found the "fair" to consist of a plain about fifteen acres in extent, in the interior of this most desolate of islands. He says that no words can give an adequate idea of the effect produced by thousands upon thousands of these wild sea-birds soaring and screaming over the arid cinder-bed, the eggs and young being scattered so thickly on the ground that it was often impossible to avoid treading on them. Only a single egg is laid, and the bird defends its treasure most courageously.

Although terns are birds which usually lay their eggs on the sand, or on the grassy flat of an island, there are some remarkable exceptions in the noddy terns of the genus *Anous* and *Gygis*.

The latter genus contains two snowy-white species, and no nest is made by them. The

single egg is often deposited on the leaf
a cocoa-nut-palm in a position, one wou
think, of great danger, but it swings in t
wind apparently without risk of being broke

The sociable weaver-birds (*Philhataerus soci*
of Africa furnish us with, I believe, the on
instance of a colony, all, as it were, under
common roof. The colony seems to be orig
ally founded by a single pair of birds, anoth
joins their nest to that of the first pair, th
a third, a fourth and so on, up to as many
three hundred and twenty pairs sometimes. T
size of such a mass of nests is so great as
cause it to be occasionally mistaken for a nati
hut. At last, by the accumulated weight, t
branch gives way and the whole comes to t
ground. This generally happens during t
rainy season when the dry grass soaking
the wet becomes too heavy to be borne long

The *ani* or "black witch," one of the Americ
cuckoos, may also be considered as a colon
breeding bird. The difference however betwe
it, and that of the weaver-bird just describe
lies in the fact that several females lay their eg
in one and the same nest and bear the duties
incubation between them.

Colonies, such as these, are only possible whe
the birds' mutual interests do not clash: whe
there is enough food in the immediate neighbou
hood for all, and some to spare.

Colonies of fish-eating sea-birds for instan
are possible, because the food-supply is almo
inexhaustible. Colonies of birds of prey a
as a rule impossible, because the food-supply

mited. On rare occasions, as on that of the reat vole plague in Scotland a few years since, wls congregated and bred so plentifully in the cality where the voles were most numerous nat they might almost be described as forming wl colonies.

Our next and last phase of this subject would eem, at first sight, to show a tendency more or ss real, to shift the burden and responsibility f family cares, either upon other birds or upon nanimate incubators. Could we trace back these ises to their origin we should probably find nat indifference to the welfare and fortunes of ne offspring followed upon a slow process of eaning, and that the parental affection had be-ome smothered as a consequence of "circum-ances over which they had no control."

The beginnings of this curious phenomenon are ndicated in the nesting of our grebes and rails. 'hese seem to endeavour to lessen the labours of ncubation by resorting to the heat generated y decaying vegetable matter dragged from the reeds in the vicinity of the nest. This is care-ully deposited upon the eggs whenever the itting bird leaves the nest.

Cowper was a little hard upon the ostrich, nd cast rather a reflection upon its Maker, hen he wrote:—

> "The ostrich, silliest of the feathered kind,
> And form'd of God without a parent's mind,
> Commits her eggs incautious to the dust,
> Forgetful that the foot may crush the trust."

et there was truth in what he said.

The facts which have been lucidly summed

up as follows by Prof. Newton appear to these: "Ostriches commonly, and especially the breeding-season, live in companies of n more than four or five, one of which is a co and the rest are hens. All the latter lay the eggs in one and the same nest—a shall pit scraped out by their feet, with the ear heaped around to form a kind of wall agair which the outermost circle of eggs rests. As so as ten or a dozen eggs are laid, the cock begi to brood, always taking his place on them nightfall surrounded by his wives, while by d they relieve one another, more it would seem guard their common treasure from jackals a small beasts-of-prey than directly to forward t process of hatching, for that is often left whol to the sun. . . ."

This hatching by artificial heat is carried its farthest by the curious Australasian mou builders or megapodes, allies of the game-birds

These build no nest, neither do they bro over the eggs to hatch them out like other bir but leave this to the heat of the sun, as is do by reptiles. The megapodes of the Solom Islands and of Celebes scratch out a hole abo two feet deep in the hot sand, deposit an eg cover it up, and leave it to the genial warm of the sun to bring it to life.

In Celebes, much of the sand is of volca origin, and black, and is chosen on this accou by the megapodes in preference to the wh sand. Therein they show great sagacity, asmuch as this absorbs much heat during t day, and loses comparatively little at nig

hite sand reflects heat. In the highlands the island there are hot springs dispersed roughout the black sand, and it was dis-vered by the Sarasins, that the birds always oose the neighbourhood of a spring in which lay their eggs. They write, "With regard the breeding of the moleos, therefore, we e able to maintain our opinion that the rd indeed lays its eggs in the sand on the t sea-shore, where the heat of the sun then oves powerful enough to hatch them; but at in the mountains, and especially in the ady forests of the interior, for the warmth of e sun must be substituted some other power, d for this purpose the moleo chooses the inity of warm water springs, which it searches t, and makes its breeding-pits in the ground rmed by hot springs. Accordingly, where oleos are encountered in the interior of Celebes, ese warm springs will be found not far off."

The other megapodes provide for their eggs in rather different fashion, forming huge mounds some five or six yards high, and thirty feet in rcumference. These mounds are made up of rth, leaves, and rotten wood. In a short time e heap becomes a most perfect hot-bed, and a st admirable incubator. Here the eggs are d, and the parent from that time ceases to take y further care of them.

Considering the great distances the birds come deposit the eggs . . . "often ten or fifteen les," writes Mr Alfred Russel Wallace, "it ems extraordinary that they should take no ther care of them. It is, however, quite

certain that they neither do nor can watch the
The eggs being deposited by a number of h
in succession in the same hole would render
impossible for each to distinguish its own; a
the food necessary for such large birds (c
sisting entirely of fallen fruits) can only
obtained by roaming over an extensive distri
so that if the numbers of birds which ca
down to this single beach in the breeding-seas
amounting to many hundreds, were obliged
remain in the vicinity, many would perish
hunger."

The chick is remarkable in that it is hatch
covered with curious feathers, differing somew
from the nestling down of other birds, and fr
the feathers worn at a later date. The qu
feathers are so long and well-developed t
the young are able to fly at birth! This occ
in no other bird.

The object of the present chapter has been
to bring together a collection of curious fa
regarding nests, but rather to illustrate h
rich in variety, and vigorous in force, is the
of the birds during this phase of their existe
—the period of nidification. By the intellige
they display at this time we have an indicat
of the height to which they have risen in
scale of evolution.

The question which most naturally arises h
is, how did this habit of building nests arise?

We may take it, I think, as an approximat
correct guess at the truth, that the earliest bi
laid their eggs upon the bare ground and hatch
them out, partly by the aid of the sun, and par

y brooding over them. Soon the latter fashion ould prevail entirely. Then, it may have been hat those which had to lay their eggs in damp laces would discover the advantages of saving heir treasures from actual contact with the round by first making a sort of bed of dry rass or sticks. Just as the common swan, for nstance, will add material to its nest to raise the ggs, immediately before a flood, the coming of hich it seems to anticipate instinctively. Later, rom various causes, and in different times and laces, such birds would be driven to seek refuge n trees and bushes for the greater security of hemselves or their eggs; and would then con- ruct, as best they could, a receptacle among ne branches precisely similar to that which ney had previously built on the ground. This eceptacle we call a "nest." Indeed migration o to speak from the ground to the trees, or *ice versâ*, happens commonly to-day. Birds ke the herons for instance that usually build n lofty trees will, in the absence of these, nake their nest upon the ground; whilst gulls, ucks, and other ground-building birds, will ften nest in trees.

At first rude, and more or less untidy structures, ; would seem that as the bird's æsthetic sense nd love of the beautiful developed, more pains nd care were taken in the construction of the est. Another contributing cause may have een the need of disguise for the purposes of rotection. The addition of moss, lichen and ieces of bark on to the outside of the nest aused it to blend so perfectly with the trunk

and branches of the tree that it became diffi
of detection and so escaped destruction.
more successful of these survive to-day. T
may we briefly trace the evolution of the bi
nest.

CHAPTER VIII.

FAMILY CARES—NURSERY DUTIES.

FROM the nest we very naturally pass to a c
sideration of the eggs contained therein.

Mr Alfred Russel Wallace has endeavou
to show that female birds, which are brilliar
coloured like their mates, lay their eggs in h
or build domed nests. This they do for
purposes of concealment, and of hiding th
gay dresses. Female birds of a sombre hu
though the male may be brilliant—do not la
holes or build domed nests. Their dull plum
effectually protects them by causing them
assimilate with surrounding objects. Mr Dar
who analyzed this hypothesis has pointed
many objections thereto.

Mr Wallace has also endeavoured to show t
birds which lay white eggs lay them in h
or concealed nests, or, in other words, ad
precisely the same tactics as they would if bles
or cursed with brilliant plumage.

It so happens that these two feature
brilliant plumage and white eggs—often oc
in one and the same bird; but frequently bi
in no sense brilliantly coloured, as petrels,

their eggs in holes, and these eggs are white also.

Now, it is quite probable that there is no desire and no need to build in holes either because the plumage is brilliant or the egg is white. Why these particular birds nest in dark places has no place in the present connection, we have simply to offer an explanation of why, whenever this occurs, the egg is white. Very probably it is for the purpose of rendering the egg visible; otherwise it would stand in hourly danger of being crushed by the parent every time it entered the nest, or lost if laid in caves or spacious cavities.

Our British puffin seems to furnish us with a concrete example of the truth of this hypothesis. At one time, like its relations the auks and guillemots and razor-bills, it laid richly coloured eggs in the open; later it has resorted to burrows, and now covers its eggs with a wash of white, sometimes so thinly that the pattern can be plainly seen shining through, sometimes the pattern is almost entirely concealed. We take it that the bird has had to whiten its eggs in order to see them in so dimly-lighted a place as a burrow. Birds lay white eggs *because* they lay in burrows, and not *vice versâ*. For a somewhat similar reason plants that are fertilized by night-feeding insects have white flowers, white being conspicuous in the dark whilst colour is invisible.

We ourselves adopt a similar expedient. Thus in the dark corridors of the Natural History Museum a piece of white paper is pasted around

the keyhole to serve as a guide thereto: underground railways the edge of the platfor is painted white to make it conspicuous, as a the edges of stairs in dimly-lighted places.

As to the coloration of the eggs and the form, and the number laid by each bird, we ne say but little.

In colour and coloration—for there is a gre difference between these two—there is an immen range and variation. As we have already r marked, the ancestral bird probably laid whi eggs. It is also probable that the majority those that breed in holes have never at any tim laid eggs with coloured shells. Colour probab owes its introduction to two factors: the ne for protection from egg-eating enemies, when th general tone of coloration is for the most part a nature resembling its immediate surrounding and the need for protection from the action the excessive light of the sun's rays. These la have, as is well known, a deleterious effect upo protoplasm or living matter. It is this need f protection from the light that has caused th black skin of the negro.

The brilliancy and the exquisite beauty the coloration of eggs cannot be dealt wit here. Some eggs, such as those of our commo British starling, wild-duck, pheasant and hero are uniformly coloured. Those of the hawk and eagles, the razor-bills and guillemots, th terns and grouse, are beautifully blotched an mottled with black or colours darker than th ground-work: those of the thrushes and re shanks are spotted. In many buntings th

markings take the form of scribblings all over the egg, and so on. The exact meaning of these various patterns of coloration is unknown, and perhaps will for ever remain so.

The colouring matter of the egg is deposited during the passage down the oviduct—the long coiled tube leading from the ovary or place where the eggs are formed to the outer world. The walls of this oviduct secrete or manufacture the colouring matter. The spots, streaks and blotches which add so much to the beauty of the egg, tell how the pigment, or colouring matter forming the same, was deposited. Thus, spots show that the pigment was deposited whilst the egg was at rest, blurred markings, whilst in motion. Sometimes the motion seems to have been rotatory inasmuch as the markings are spiral in character, as is well seen in the eggs of many guillemots.

For the most part birds nearly allied lay similar eggs, but there are many exceptions to this rule. The general truth of this fact, however, is unquestionable. It was the recognition of this that led ornithologists to perceive the close relationship between the gulls and plovers which, till then, had always been considered very distantly allied; other and anatomical characters were later brought to light which confirmed their observations.

The texture of the shell varies much. It may be most extraordinarily smooth and polished resembling burnished metal or highly glazed porcelain, as in the tinamous, or smooth and greasy as in the ducks; or covered with a thick chalky

layer, as in the cuckoos known as the guira a
the ani; or in the rosy flamingo and our Brit
Sclavonian grebe. In the ani, if this layer be
moved, the shell beneath will be found to be
a brilliant blue colour. In the ostrich and e
and some others the surface is deeply pitted.

The condition of the young when hatch
depends largely upon the relative size of t
egg. Thus in birds which lay small eggs t
young are, at birth, blind and helpless; wh
the egg is relatively large the young will
found to be very active within a short ti
after birth, and able to feed themselves. T
former group of birds build more or
elaborately constructed nests, the latter lit
or none. This ratio between the size of
egg and the condition of the chick at birth
caused a great disproportion in the relat
size of the egg and the bird which produces
Thus the guillemot and the raven are birds
equal size, yet their eggs vary as ten to one,
egg of the guillemot being relatively huge, a
as large as that of an eagle.

The smallest egg of living birds is that of
humming-bird, the largest that of the ostri
The largest known bird's egg is that of the
tinct Æpyornis of Madagascar. An egg of
latter is often found in the lap of the skeleton
some chief, as though placed there to afford
spirit sustenance on its long journey to the ot
world, the custom of providing the dead w
food and even raiment and weapons being a v
wide one amongst primitive people. The girth
this egg is about thirty inches, its longest circu

ference is about thiry-six inches, and its capacity about four gallons!

The form of the egg varies; it may be almost perfectly spherical elliptical, oval, or pear-shaped. Some owls and the diving-petrel lay round eggs; in the sand-grouse they are elliptical, oval in the common partridge and turkey, pear-shaped in the plovers.

The shape of the egg in most birds has apparently no definite use or meaning. In the guillemot, however, the long conical form has evidently a definite use. These birds lay their eggs on the bare flat surface of some ledge on a rocky cliff; when the wind blows with sufficient force to move the egg it turns round upon its small end. If it were round, it would roll off into the sea. In the case of the plover the pear-shape is a most economical one, as, in the nest, but little space is taken up, the eggs being deposited with their small ends inwards, and thus the female is enabled to cover them all when sitting.

The eggs laid and brooded over at one time, in one nest, form a "*clutch.*" The number of eggs in a clutch varies. The razor-bills of our coasts for instance lay but one, the guillemots two, the sand-grouse three, the common sand-piper four, the robin five, the long-tailed tit nine, the partridge twelve. The number of the eggs in a nest affects their size, for it is necessary that all the eggs in the nest should be covered at the same time by the sitting-bird to ensure their hatching out together. Thus, if the partridge lays twelve eggs, it is obvious they cannot be as large relatively as in the snipe which lays but

four. Since the young of both run almost soon as they are hatched, we are admonished exercise caution in generalising as to the size the egg and the condition of the young at birt In the main, however, the remarks made on th point hold good.

We have seen something of our feather friends during the period of courtship wh they appear perhaps at their best, we ha followed them through the first period of the trial—the building of the nest—and we ha incidentally got a glimpse of them at a sta later still—the period of incubation. We ha already, in this present chapter, briefly survey the various forms, colours, numbers, and so o of the eggs these nests were made to contai and now we are about to pass on to see ho birds acquit themselves as parents.

In all but a few exceptional cases the bulk the work of incubation and feeding the you falls upon the female. When not actually sitti on the eggs, or feeding, she sits near and watch them with the tender care and solicitude that h become synonymous with the name of mothe For example, the female osprey (a fish-eati bird of prey), which is in the habit of leavin her eggs for a short time each day exposed the sunlight, has been seen to plunge headlon into the lake below, and rising to shake h dripping plumage over her treasures lest t much heat should injure them. Having do which she returned to her perch to meditate

Among the ducks, the building of the nest, t hatching of the eggs and the feeding of the you

ll devolve upon the female. The male either etires from the neighbourhood with other males, r fills up the time in moulting. The eider-duck or this purpose goes out to sea; the common British wild duck retires to the seclusion of some eed-bed.

With the hawks and eagles the thoroughness vith which these duties are carried out varies.

Of the eagle, for instance, Capt. Bendire vrites that, "notwithstanding the many sensaional stories of the fierceness and prowess of he golden eagle, especially in the defence of ts eyrie, from my own observations I must onfess that, if not an arrant coward, it certainly s the most indifferent in respect to the care of ts eggs and young that I have ever seen. This nay possibly be due more to utter parental indifference than to actual cowardice. . . ." A pair of merlins, on the contrary, gave proof of eal affection. Having been fired at several imes when on the nest they transported the ggs to a bank forty yards distant, placed under hem a few leaves by way of a nest, and succeeded n hatching them out successfully.

In the common buzzard both male and female it upon the eggs: in the harrier the female only. n both species the males assist in feeding the young.

In the courser, a plover-like bird sometimes visiting Britain, the female only attends to the ggs, the male returns to assist in the feeding nd care of the young.

In most of the game-birds the duties of inubation and the care of the young fall entirely

upon the female. In defence of his family, however, it would seem that the cock will often fight courageously. A story is related of a hawk which attacked a hen and her chickens, when the cock rushed to the rescue and drove his spur right through the eye and into the skull of the would-be spoiler. The hawk was killed instantly and when disentangled from the cock, which had gripped with great tenacity, the victorious champion was found quite uninjured.

With the owls it does not appear that the males actually take any part in the incubation but it is certain that they remain in the neighbourhood and jealously attack all who approach within what are considered desirable limits.

The value of these birds, by the way, at that time of the year, during which they have young to feed, is hard to estimate, for they devour—at all times of the year—rats and mice and voles for the most part, and the number which is brought daily to the nest by *both* parents—for the male assists in the feeding—is prodigious. Yet, these birds are slain right and left by gamekeepers and others who should know better and their poor mutilated bodies gibbeted on barn-doors as those of malefactors!

The bar-tailed pigeon (*Columba fasciata*) of North and Central America appears to have the parental feeling largely developed. It has been several times seen when frightened to carry its egg from the nest and bear it away to another tree. Selecting a large branch thereof on which to deposit its precious burden, it proceeds with the incubation forthwith.

The plovers, and many other birds, draw
truders from the neighbourhood of the eggs
young by feigning to be wounded, the object
ing to entice all such away by holding out the
ope of an easy capture. As soon as a sufficient
stance has been covered the bird takes wing and
aves its would-be captor greatly discomfited.

The woodcock has frequently been known to
rry its young long distances when threatened
r any danger. This it does by pressing the
tle chick to its breast by the aid of its beak,
d giving support from below with its feet.
me however say it is carried between the
gs without any aid from the bill.

Amongst the ostrich tribe, the duties of in-
bation are almost entirely performed by the
ale, who with the female accompanies the
ung for some time.

This also occurs in some other birds. For
stance, the phalaropes (plover-like birds), the
inted snipe, and the bustard-quails. In all
ese, strangely enough, the females excel both
size, and beauty of colouration. Whenever
eir superiority in these respects obtain, as we
ve remarked in an earlier chapter, it is the
male bird which does the courting.

The period of incubation lasts from ten days
the little Australian zosterops to sixty in the
trich.

Some of the methods of feeding the young are
ell worth notice. In the pigeons, for instance,
e mucous membrane lining the interior of the
op becomes extraordinarily active during the
eeding-season, and peels off in the form of a

cheese-like or milky secretion with which bo parents feed the young for some time. This sec tion is familiarly known as pigeon's-milk." In fe ing, the nestling thrusts its beak into the mouth the parent, who then forces down its throat t peculiar food with a kind of pumping action.

In the cormorant, a similar method of feedi is followed: the baby cormorant thrusting head and neck down the throat of its fond pare and taking from its well-filled gullet as much f as it can manage to swallow.

In the pelican—a near relative of the c morant—the female only attends to the feedi of the young. This is effected by the par pressing its beak against its breast and rais the upper jaw, upon which the young h themselves to the fish in the pouch. T habit probably gave origin to the fable the pelican feeding its young on the blood of own breast.

As we have seen already, the male horn feeds his mate by regurgitating his latest m enclosed in the form of a neat package, furnis by the inner lining of his gizzard.

The woodpeckers again feed the young regurgitation. The partly-softened food f the parent's crop is passed into the mouth of young which is opened to receive the beak the parent.

The condition of the young at birth var very much. They may, on this account, divided into two great groups: (1) Those wh remain for a longer or shorter time in the ne perfectly helpless, and requiring to be fed

he parents, and (2) those which are enabled to eave the nest immediately after birth.

Those of the first group are born blind and often naked. One may roughly divide the members of this group into four separate sections :—

1. Those born clothed in a thick coat of downy feathers, such as hawks, owls, and petrels.
2. Those born naked or almost naked, but which rapidly develop a downy covering, such as the herons and storks and gannets.
3. Those born naked but which never develop more than a few dark down feathers in no wise capable of covering the body, such as the crows.
4. Those born naked and never developing any kind of nestling down whatsoever, such as kingfishers, hornbills, swifts, woodpeckers, and humming-birds.

The nestling down is of two types, one or both of which may be present at the same time. The first kind is that which is followed by feathers; the second, that which is followed by down. The second is sometimes absent in young birds, — as in ducks; — and sometimes forms the greater part of the clothing of the body at this time.

The nestlings of the second group are all born with their eyes open and clothed with nestling down, which is sometimes hard to distinguish from the feathers; they run soon after they are hatched. Such are chickens, ducks, geese and swans, plovers, cranes, and so on.

These are able to feed themselves almost a
once, and only require the mother to guide the
to places where food is procurable, to instruct the
what is good to eat, and to keep them warm a
night, and protect them from enemies. Withou
her they would roam about and soon get lost.

In almost every case, so soon as the young ar
old enough to look after themselves, they a
driven away from the neighbourhood of the
birthplace to seek homes elsewhere. This
really a wise act. It prevents too many of on
species collecting in the same area, and thu
obviates two serious evils threatening the welfa
of the whole species. The first of these is th
danger accruing from too many of one kin
feeding in the same area, since the demand f
food would soon exceed the supply. The secon
is the danger of too close interbreeding, whic
would weaken the race and bring about i
inevitable extinction.

In all birds, except perhaps those of th
ostrich tribes, the tip of the upper jaw is arme
with a tiny, but very hard, conical boss calle
the "egg-tooth"; with this it breaks the wall
its shell and so liberates itself. Soon after th
egg-tooth is thrown off.

For some hours before hatching, the chick ca
be heard giving vent to that peculiar little cr
known as "cheeping." If danger threatens,
warning note is given by the parents, then all
still at once. So that the little stranger begi
his education actually before he is born!

We have reserved till the last a considerati
of the remarkable habits of certain unnatur

arents, commonly and rightly described as arasitic birds. Though individual cases of this ind are comparatively rare, the facts concerning nem are really striking.

First of all let us take that of our British uckoo. It is a matter of common knowledge, robably that this bird always lays its eggs n that of other birds, and leaves to them the ntire responsibility of hatching and rearing s offspring.

Exactly how the egg is placed in the nest as, until recently, a matter of much controversy. or it was often found in a nest so completely nced in by brushwood, or in one so small as to ake it quite impossible that it could have en "laid" in the ordinary manner. It is w known that it is laid first upon the bare round, then taken up in the beak, carried to the me of the victim selected, and dropped in.

From the laborious observation of a German aturalist named Rey, we have learned much ncerning the choice of nests made by the ckoo.

A large per centage of the nests selected in s district were those of the red-backed shrike; t, as in England, those of the wagtail, robin, lackbird, thrush, hedge-sparrow, pipit, bunting, ed-warbler, and so on, were also requisitioned. e further found, and his observations have been nfirmed from many sources, that each particular ckoo will always select the same kind of nest which to lay; and that probably of the ecies by which it had itself been reared. The g, moreover, generally bears a striking re-

semblance to that of the species selected to a
the part of wet-nurse. He claims to be able
recognise every egg laid by any particular bi
not only during that season but during eve
season so long as she continues to return ea
year to the same district to lay in. This
seems able to do from the fact that each cuck
has a more or less distinctive colouration for
shell, which makes it perfectly easy to identif
it is a sort of visiting-card. Thus, if a bird la
in a red-backed shrike's nest its egg will resem
that of this species; if in a pipit's, then of th
and so on. If the red-backed shrike be the vict
selected then she will go the round of all t
red-backed shrikes' nests in the neighbourho
laying an egg in each, till all her stock of eg
for that year is exhausted. Only, it appea
when there are no more nests of the requi
species to be found will she drop her egg i
that of some other. The resemblance betwe
the egg of the cuckoo and that of the fost
parent selected is attributed to the influe
of the food during the nestling period of ea
particular cuckoo. The colouring matter of a
the red-backed shrike's egg is more or less det
mined by the nature of the parent's food. T
nestling cuckoo, being fed like a nestling shri
the influence of this feeding is transmitted throu
the germplasm to its offspring. Shrike and cuck
in this respect, are influenced alike. The sou
ness of this conclusion has yet to be tested.

Having been reared by shrikes, it seems t
it cherishes a certain sort of affection for them, a
on arriving at maturity entrusts its offspring

the same fostering care. In course of time we thus get a "*gens*" of shrike-reared cuckoos, another of robin or wag-tail, reared, and so on.

The same cuckoo will return year after year to the same locality to lay, and will permit no other of its species to share her territory, not even such of her own offspring — should she recognise them—as were born there the year previously.

If we feel that this desire to shirk the responsibilities of parentage is somewhat reprehensible what shall we say of the young, when we learn that its earliest act, before it has seen the light of day—for it is born blind—is *murder*! The story of the deliberate, relentless fashion with which this is carried out has been graphically told by Mrs Hugh Blackburn as follows: "The nest (which we watched last June after finding the cuckoo egg in it) was that of the common meadow-pipit (titlark, moss-cheeper), and had two pipit's eggs besides that of the cuckoo. It was below a heather bush on the declivity of a low abrupt bank on a highland hillside in Moidart.

"At one visit the pipits were found to be hatched, but not the cuckoo. At the next visit, which was after an interval of forty-eight hours, we found the young cuckoo alone in the nest, and both the young pipits lying down the bank, about ten inches from the margin of the nest, but quite lively after being warmed in the hand. They were replaced in the nest beside the cuckoo, which struggled about until it got its back under one of them, when it climbed backwards directly

up the open side of the nest and hitched th
pipit from its back on the edge. It then stoo
upright on its legs, which were straddled wi
apart with the claws firmly fixed halfway dow
the inside of the nest, among the interlacin
fibres of which the nest was woven, and stretc
ing its wings apart and backwards, it elbow
the pipit fairly over the margin so far that it
struggles took it down the bank instead of ba
into the nest. After this the cuckoo stood
minute or two feeling back with its wings,
if to make sure that the pipit was fairly ove
board, and then subsided into the bottom of th
nest.

"As it was getting late, and the cuckoo did n
immediately set to work on the other nestling,
replaced the ejected one and went home. C
returning next day both nestlings were foun
dead and cold out of the nest. I replaced on
of them, but the cuckoo made no effort to g
under and eject it, but settled itself contented
on the top of it. All this I find accords accu
ately with Jenner's description of what he sa
But what struck me most was this: the cuck
was perfectly naked, without a vestige of
feather, or even a hint of feathers, its eyes we
not yet opened, and its neck seemed too wea
to support the weight of its head. The pipi
had well-developed quills on the wings and bac
and had bright eyes partially opened, yet th
seemed quite helpless under the manipulations
the cuckoo, which looked a much less develop
creature. The cuckoo's legs, however, seem
very muscular, and it appeared to feel about wi

ts wings, which were absolutely featherless, as with hands, the bastard wing (unusually large in proportion) looking like a spread-out thumb. The most singular thing of all was the direct purpose with which the blind little monster made for the open side of the nest, the only part where it could throw its burthen down the bank. I think all the spectators felt the sort of horror and awe at the apparent inadequacy of the creature's intelligence to its acts that one might have felt at seeing a toothless hag raise a ghost by an incantation. It was horribly 'uncanny and gruesome.'"

His fell purpose effected, the little murderer settles down to greedily absorb the nourishment which should rightfully have been shared between himself and foster brothers and sisters. In about a fortnight he is completely fledged and can leave the nest. But he by no means releases those upon whose charity he has been thrown. Up to within a short time of his leaving the land which gave him birth he holds them in thraldom,—"the victims of his mother's dupery," to quote Prof. Newton. As this writer further remarks, "Their actions when he attains his full stature become almost ridiculous, for they have often to perch between his shoulders to place in his gaping, upturned mouth the delicate morsels he is too lazy or too stupid to take from their bill. The time during which he is thus supported by his foster-parents has not been determined, but it seems to last for some weeks."

If we have an instance of crime in Nature it seems to be here. The desire to explain the origin

of habits so extraordinary is a natural one. we take into consideration the habits of the adul the nature of its food, and the proportion of th sexes, we shall have the first clue to the myster

All these seem to combine in favour of degraded habit of life. They are the factors work in the making of our avian criminal The bird by disposition has been described as "discontented, ill-conditioned, passionate, i short, decidedly unamiable bird." The not itself, and the manner in which it is emitte are typical of the bird's habits and characte Abruptness, insatiability, eagerness and rag are noticeable in its whole conduct. "Thes birds verify in many ways the old myth th they are sparrow-hawks in disguise. Th parasitic habit is consonant with their gener character."

There is "too much hunger and gluttony write Messrs Geddes and Thompson, "for th higher development of love."

Our common cuckoo is not the only offende for one of the cuckoos of South Europe an North Africa selects the nests of magpies an crows to serve as nurseries for its young. Th eggs of this cuckoo are said to resemble those the crows and magpies so closely as to make difficult even for the expert egg-collector to di tinguish between them.

The cow-birds of North and South Americ are parasitic in the same way. The habit probably due to the same causes. Innutritiou food and predominance of males, resulting i polyandry. These birds have a habit of peckin

bles in some of the eggs in the nest of the selected ictims, and this is about the only mark of care hich they show for the future of their progeny. ut for this precaution the little uninvited guest ight starve in the midst of plenty. Of the gs which are left, most, if not all, hatch out; e little nestlings are soon however despatched, -not in the way adopted by our cuckoo, but ther by the simple expedient of sitting on and nothering them, or by seizing all the food ought to the nest and so starving them. The w-bird is probably doomed to extinction, for ough a large number of eggs are apparently oduced by each bird, only a small proportion er succeed in being hatched. A considerable rcentage are said to be laid in empty nests, me are dropped on the ground, and some stroyed by the parents themselves by being piked like those of their victims!

Another South American bird, one of the angnests (*Cassidix oryzivorus*), places its egg in ie nest of another hangnest (*C. persicus*); but o far as is known no destruction of the young the host takes place in consequence.

The case of the koel, a cuckoo found in India nd the Malay Archipelago, is one of great in-rest, combining the habits both of mimicry and rasitism.

The female of this cuckoo—as with others—iffers in coloration from the male, which is black. ut though it generally happens when this is ie case, that the young resembles the female, this particular instance the young cuckoo, ke its *male parent* is *black*. Now the host

selected by this cuckoo to perform her ov
neglected duties is a species of starling known
the Myna (*Eulabetes Javanensis*). The peculiari
of this bird is, that both male and female a
alike, black, and the young is also black. If t
young cuckoo was clad like its mother, t
Mynas would promptly kill it on detecting t
fraud. Dressed in black, it passes as one
their own, and as such is carefully reared.

CHAPTER IX.

MIGRATION.

THE facts of migration are being constant
thrust before us, yet but few do more th
dimly realise the marvels that they represent,
that they exist at all.

Some of us find a passing interest in the a
nouncement by the morning paper, of the a
pearance of the first swallow or of the cucko
but how many are aware of what this mean

And yet, as Prof. Newton remarks, we "a
brought face to face with perhaps the greate
mystery which the whole animal kingdom presen
—a mystery which attracted the attention of t
earliest writers, and can in its chief point
no more explained by the modern man of scien
than by the simple-minded savage or the po
or prophet of antiquity. Some facts are almo
universally known, and have been the theme
comment in all ages and in all lands. T
hawk that stretches her wings towards the Sou

s as familiar to the latest Nile-boat traveller or weller on the Bosphorus as of old to the uthor of the Book of Job. The autumnal hronging of myriads of water-fowl by the rivers f Asia is witnessed by the modern sportsman s it was of old by Homer. Anacreon welcomed he returning swallow in numbers which his mitators of the colder north, to whom the ssociation connected with it are doubly strong, ave tried in vain to excel. The Indian of the ur-countries, in forming his rude calendar, names he recurring moons after the birds-of-passage whose arrival is coincident with their changes. But there is no need to multiply instances. The low and ebb of the feathered tide has been sung by poets and discussed by philosophers, has given rise to proverbs and entered into popular superstitions, and yet we must say of it still that our 'ignorance is immense.'"

We may however take "heart of grace" for his pile of ignorance is being slowly demolished; and the traditions, legends and superstitions, of which it was made up, are being slowly consumed by the fire of criticism. As a result, we can now class the observed phenomena under three heads and speak of (1) accidental migrants, (2) birds-of-passage, and (3) migration proper.

As this last is the most important and the most typical, we will discuss it first. This section then treats of the periodic movement of large bodies of birds from one place to another, often thousands of miles apart.

Concerning migration proper, we have learnt this—that species which winter with us, leave in

the spring to nest nearer to or within the arct
circle, and the species which summer and n
with us, winter near the equator.

With some species every individual disappea
as for instance our swallow and fieldfare; wi
others, such as the robin, thrush, and lark
receive immigrants every year. Emigration
these species is less marked, but occurs.

Nearly every bird, as Prof. Newton remin
us, migrates in some part or other of its rang
a fact which suggests that the phenomena of m
gration are probably universal.

But whether this migration be extended to
farthest or confined to its smallest possible lim
we find one trait common to all—a "passiona
fondness for the old home."

Prof. Newton has given us two very striki
instances of this. The first of these is one
our most sedentary birds—the blue titmou
(*Parus cæruleus*). A pair of these birds in 17
or according to some, 1785, "built their nest
a large earthenware bottle placed in the branch
of a tree in a garden at Oxbridge near Stockto
on-Tees. With two exceptions only, this bot
. . . was tenanted by a pair of birds of th
species from the year in which it was fi
occupied until 1873, when I saw it . . . but
regret to add that I learnt through Can
Tristram in 1892 that the occupancy had ceas
for four years."

The second case is that of a stone-curlew
very migratory species. A pair of these bir
returned year after year to the same spot
breed though the character of the locality h

completely changed. "It had been part of an extensive and barren rabbit-warren, and has become the centre of a large and flourishing plantation."

The affection of the swallow for its old nesting-place is well-known, and many of my readers will doubtless recall other instances.

In studying the phenomena of migration we must pay careful attention to the sources of food-supply, the nature of the food, and the method of procuring it.

Hawks, as we know, drive away their young from the neighbourhood in which they were born, as soon as they have taught them to hunt and kill for themselves. The apparent selfishness and cruelty on the part of the parents in such treatment is, in reality, an act of kindness. From their mode of life, a given area can only support a few individuals, and for parents and offspring to remain in the same locality would rapidly mean starvation for all. Some birds there are which traverse the country-side during the autumn and winter in small family parties. Such are, for instance, insectivorous birds. Amongst these it is obviously an advantageous plan; for the discovery of food at this time is an arduous task, and if undertaken individually, many would surely starve, as Prof. Newton points out. "A single titmouse searching alone might hunt for a whole day without meeting with a sufficiency, while if a dozen are united by the same motive, it is hardly possible for the place in which the food is lodged to escape their detection, and, when

discovered, a few call-notes from the lucky finde are enough to assemble the whole company t share the feast. . . . One tree after another visited by the active little rovers, and its branch examined: if nothing be forthcoming, away goe the explorer to the next that presents itsel merely giving utterance to the usual twitter tha serves to keep the body together. But if th object of search be found, another kind of chir is emitted, and the next moment the severa members of the band are flitting in successio to the tree, and eagerly engaged with th spoil."

This need of food, it is suggested by the sam writer, is probably largely responsible for th movement of the birds of our northern hemi sphere, southwards, a movement which cease only at the equator. But what, he asks, induce the return journey with all its attendant dangers Probably again a lack of food, not necessarily fo the migrants, but for their nestling offspring There is sufficient for the parents, but this is no of a nature adapted for the requirements of th nursery, which can only be found in the land lately left, where, at this time the supply wi meet all demands likely to be made upon i Perhaps, he suggests, this may be the explanation but perhaps again the real motive is "the passion ate fondness for the old home."

Indirectly, these periods of passage are a grea benefit to the race generally, for in the course o them, the ranks of the travellers are greatl thinned by reason of the numbers who fall b the wayside. Only the strongest and mos

tive survive to perpetuate the species. The mber of swallows often found dead on the ashore washed up by the restless waves after storm affords a proof of this mortality.

The regularity of these migratory movements wonderful. Fair weather or foul the puffin rns up at his accustomed breeding-place ith clockwork regularity. The swift again peculiarly punctual in the date of his arrival. Mr Wallace seems most strongly of opinion at food is the mainspring of migratory move-ents. He says:—

"It appears to me probable that here, as in so any other cases, 'survival of the fittest' will be und to have had a powerful influence. Let us ppose that in any species of migratory birds, eeding can as a rule be very safely accomplished a given area; and further, that during a great rt of the rest of the year sufficient food cannot obtained in that area. It will follow that ose birds which do not leave the breeding area the proper season will suffer, and ultimately come extinct; which will also be the fate of ose which do not leave the feeding area at the oper time. Now, if we suppose that the two eas were (for some remote ancestor of the isting species) coincident, but by geological d climate changes gradually diverged from ch other, we can easily understand how the bit of incipient and partial migration at the oper seasons would at last become hereditary, d so fixed as to be what we term an instinct. will probably be found that every gradation ill exists in various parts of the world, from a

complete coincidence to a complete separation
the breeding and the subsistence areas; wh
natural history of a sufficient number of spec
is thoroughly worked out, we may find every li
between species which never leave a restrict
area in which they breed and live the whole y
round, to those other cases in which the two ar
are absolutely separated."

We have one striking instance of the relati
between migration and food in the passen
pigeon, *Ectopistes migratorius*. Concerning t
Dr Brewer writes, "The wild pigeon appears
be almost entirely influenced in its migration
the abundance of its food, excepting in th
parts of the country in which it has not b
known to remain during the winter. Even
these movements it is largely influenced by c
siderations of food. . . . They are capable
propelling themselves in long continued fligh
and are known to move with an almost incredi
rapidity, passing over a great extent of coun
in a very short time. It is quite a common a
well ascertained fact that pigeons are captured
the state of New York with their crops still fil
with the undigested grains of rice that must h
been taken in the distant fields of Georgia
South Carolina, apparently proving that t
must have passed over the intervening sp
within a very few hours. Audubon estima
the rapidity of their flight as at at least a mi
minute. . . . Mr Audubon relates that in 1
. . . in crossing the barrens near Hardensbu
he observed these birds flying to the south-w
in greater numbers than he had ever kno

before. . . . The air seemed filled with pigeons, and the light of noonday to be obscured as by an eclipse. Not a single bird alighted, as the woods were destitute of mast, and all flew so high that he failed to reach any with a rifle. He speaks of their aërial evolutions as beautiful in the extreme, especially when a hawk pressed upon the rear of a flock. All at once, like a torrent, and with a noise like that of thunder, they rushed together into a compact mass, and darted forward in undulating lines, descending and sweeping over the earth with marvellous velocity; then mounting almost perpendicularly in a vast column, wheeling and twisting so that their continued lines seemed to resemble the coils of a gigantic serpent. During the whole of his journey from Hardensburg to Louisville, 54 miles, they continued to pass in undiminished numbers, and also did so during the three following days. At times they flew so low that multitudes were destroyed, and for many days the entire population seemed to eat nothing but pigeons."

"There can be little doubt," to quote another writer, "but that the vast numbers of these pigeons have greatly diminished during recent years; and though at present by no means on the verge of extinction, it seems certain that unless laws be made for its protection its extermination is only a matter of time." Mr Brewster writes that in Michigan, "we found the flocks of pigeons had passed there late in April, while there were reports of similar flights from almost every country in the southern part of the State. Al-

though most of the birds had passed on befor
our arrival, the professional pigeon-netters, conf
dent that they would finally breed somewhere i
the southern peninsula, were busily engaged ge
ting their nets and other apparatus in order fo
an extensive campaign against the birds."

The largest nesting-place he ever visited w
in 1876 or 1877. It began near Petosky, ar
extended north-east past Crooked Lake for 2
miles, averaging 3 or 4 miles wide. The bir
arrived in two separate bodies, one directly fro
the south by land, the other following the ea
coast of Wisconsin, and crossing at Manito
Island. He saw the latter body come in fro
the lake at about three o'clock in the afternoo
It was a compact mass of pigeons, at least
miles by 1 mile wide. The birds began buildi
when the snow was twelve inches deep in t
woods, although the fields were bare at the tim
So rapidly did the colony extend its boundari
that it soon passed literally over and around t
place where he was netting, although, when
began, this point was several miles from t
nearest nest. Nestings usually start in deciduo
woods, but during their progress the pigeons
not skip any kind of trees they encount
The Petosky nesting extended 8 miles throu
hardwood timber, then crossed a river—botto
wooded with arborvitæ, and thence stretch
through white pine woods about 20 miles. F
the entire distance of 28 miles every tree of a
size had more or fewer nests, and many trees we
filled with them. None were lower than abo
15 feet from the ground. Pigeons are ve

noisy when building. They make a sound resembling the croaking of wood-frogs, and their combined clamour can be heard at a distance of 4 or 5 miles when the atmospheric conditions are favourable.

There are one or two notable facts which are well worth mentioning in this connection. Thus, it seems to be well-established that in many species the males arrive sometimes days, or even weeks, before the females. In the autumn the adults often leave first, leaving the young to follow later—and generally by a different route. The cuckoo is an instance of this. How these young find their way is a mystery. An innate sense of direction has been suggested as a possible explanation, but this is not very convincing.

The routes followed by some of our more familiar friends will doubtless prove of interest. Concerning this subject comparatively little is really known. Facts however are being slowly accumulated. In Great Britain, much valuable and lasting work has been, and is being done, by Mr Eagle Clarke. Much more has been done by the careful collection of birds' skins from all parts of the world as may be found at the British Museum. From such collections, for instance, we gather that our common swallow winters on the west coast of Africa.

The "birds-of-passage" to which we referred at the beginning of this chapter are those on their way to and from their breeding-grounds, outside the limits of these islands. They make but a brief sojourn—possibly for rest and food—and then disappear.

Besides these, as already hinted, we hav occasional stragglers. Such, for instance, ar many North American birds breeding in hig northern latitudes; which, on their return hom get blown out of their course by violent westerl gales.

But how is it, some will naturally ask, tha we see little or nothing of all this movement Chiefly, we may answer, because for the mos part it takes place at such great altitudes as t make it invisible and inaudible. What we *d* see and hear is only an indication of what i going on above.

Mr Chapman, in America, by directing a power ful telescope towards the moon, has detected bird passing at night in great numbers at a heigh of from one to (?) five miles. Similar observation have been made by day, by directing a telescop against the sun. It seems to be only in storm or cloudy weather that migrants descend lo enough to be seen or heard. Our lighthous keepers have rendered valuable aid in observa tion of the movements of the birds which pas their stations. Their records have been pu lished in a series of reports instigated by th British Association, the net result of which wi be shortly given to the world by Mr Eag Clarke, one of our greatest authorities on bir migration. It has been shown that during ba weather the birds descend, and then seem t be attracted to, and dazzled by, the powerf beacons of the lighthouses and lightships—a attraction which proves fatal to thousands, f in many cases they are killed instantly by th

violence of their impact with the glass condensers of these beacons. Hundreds of all species: woodcocks, snipes, curlews, ducks, finches, crows, owls and so on, hover around till daybreak then make for the shore; but hundreds remain, either utterly exhausted with their exertions, or killed by concussion.

If the lighthouses have told us much, the lonely island of Heligoland—an island which is peculiarly well situated for work of this kind—has told us more. The observations from this quarter are by far the most numerous, and the most valuable that have yet been made. These we owe to the late Herr Gätke who spent the greater part of a long and useful life on this circumscribed spot. He studied the movements of the birds as they passed and repassed, as the seasons rolled, with the greatest care and minuteness. Sometimes they would come to the lighthouse, as to the lighthouses in other places, in enormous numbers. One night for instance in October, "Goldcrests eddied as thick as flakes in a heavy snowfall . . . on the morrow literally swarming on every square foot of the island; and twelve months later larks in myriads thronged to the bright beams of this same beacon four nights in succession, accompanied by starlings in hardly fewer numbers."

There is another form of migration, hinted at in the beginning of this chapter, which might almost be described as spasmodic. It is just possible however that it is really periodic, or at least occurs in cycles.

This is the immigration of vast hordes of birds

normally sedentary in their habits. Our shore have at different times harboured thousands o the refugees belonging to different orders o birds.

The most remarkable of these immigrations that of the Pallas's sand-grouse (*Syrrhaptes paradoxus*). This bird, an inhabitant of the plains o Tartary, has, so to speak, invaded England o several separate occasions. The first of thes was in 1863 when numbers were killed. Anoth of far greater magnitude occurred in 1888. I Norfolk alone between 10,000 and 12,000 a computed to have been seen, exclusive of th large number killed.

The cross-bill frequently, and the waxwin more seldom, cross to these islands in more o less numerous bands ; but these occurrences a very irregular, and so far remain entirely une plained.

CHAPTER X.

THE DISTRIBUTION OF BIRDS IN TIME AND SPAC

THE present chapter is intended to serve mo or less as a prelude to the one that follows.

The distribution of birds in time is witness by their fossil remains. Thus, if we know t geological formation from which they were take we are enabled to gather some notion as to t nature of the bird-life of that particular peri of the world's history, and an idea as to t extension backwards in time of this group.

If our notions concerning the evolution of higher from lower groups, and of their gradual transformation into species, be correct, we should expect to find that the further back in time we could trace any given animal, the more unlike its present self, so to speak, would it become. At first the change would be hardly perceptible, but at the last it would be marked indeed, so much so, that could we compare the ancestral form with its latest descendants, we should find that they would have but very little in common.

The history of some of the hoofed mammalia very well bears out this hypothetical case.

With the birds, unfortunately, the "missing links" are numerous. The marvel is that we have any record at all. As that distinguished authority on fossils, Mr Arthur Smith Woodward, of the British Museum, has reminded us. "We may . . . without exaggeration, declare that every item of knowledge we possess concerning extinct plants and animals depends upon a chapter of accidents. Firstly, the organism must find its way into water where sediment is being deposited, and there escape all the dangers of being eaten; or it must be accidentally entombed in blown sand or a volcanic accumulation on land. Secondly, this sediment, if it eventually happens to enter into the composition of a land area, must escape the all-prevalent denudation (or destruction and removal by atmospheric and aqueous agencies) continually in progress. Thirdly, the skeletons of the buried organism must resist the solvent action of any waters which may percolate through the rock. Lastly, man must accidentally excavate

at the precise spot where entombment took plac
and someone must be at hand capable of apprec
ating the fossil and preserving it for study whe
discovered."

The most ancient bird known carries us as fa
back in the world's history as the period and a
we call the Jurassic. Its contemporaries were th
huge marine fish-lizards—the ichthyosaurus an
the plesiosaurus. On land there roamed th
mammoth lizards, Brontosaurus and Atlant
saurus. The former was 50 feet long, and ha
left footprints measuring a square yard in are
The latter was some 100 feet long, and 30 fe
or more in height.

The mammals were yet in their infanc
Probably none exceeded a few inches in length

Amongst the rivals of this ancient bird i
creatures that fly, there were no mammals a
at the present day—the bats. But their plac
was filled by swarms of flying reptiles—th
pterodactyles, or wing-fingered lizards. Lizard
indeed were the dominant form of life. At th
period they had reached the zenith of their glor
and ruled where now the bat and the bird hol
sway, and not only in the air, but on *terra firm*
as well.

This bird we know as the *Archæopteryx*,—th
ancient winged-bird. As we shall see in th
next chapter, it differs in many importan
details from all other known birds. But, a
the same time, it is undoubtedly a bird.
possesses, in a remarkable degree of perfectio
one of the birds' most striking characteristics—
feathers. The form of its leg and foot is scarcel

fferent from that of the rooks and crows of to-ay. The fashion of wing-bones is the same theirs. Where it differs from them, its ounterpart can be found in living birds.

These are points of great significance. We ave no reason to suppose that they reached is particular form by any other than the rdinary routes, which were then as now. The ing and foot as we see them in the fossil must e the result of a gradual modification of some her pre-existing type of fore- and hind-limb.

This modification must have been a very very ow one, and pre-supposes a long line of ancestors retching back far beyond the Jurassic period.

The argument for descent with modification, hich is the outcome of the evolution hypothesis, ay be admitted to have received strong supp ort nen from this skeleton.

The two birds now to be discussed afford us dditional evidence, for in the one we see what volution has accomplished by specialisation ccompanied by degeneration; in the other e have an object lesson in evolution with rogression, and in both we have evidence of distinct advance in type. Both the forms oreover are contemporaries, showing that the vo were being evolved at the same time.

These are *Ichthyornis* and *Hesperornis* of the retaceous period.

Both of these were more advanced in type han *Archæopteryx*. In *Ichthyornis* the form of he tail and wing is like that of modern birds, o is the pelvis. Its powers of flight were robably vastly superior, for its breast-bone was

provided with a deep keel for the attachm
of powerful muscles to move the wings. Fr
the general form of the body and legs there
no doubt that it was a dweller on the s
shore, and could swim, and perhaps even di
easily. In this, you will note, we have evide
first of progress in development, in time; a
secondly, of the modification of the skeleto
suit changed requirements. The first bird w
a dweller in trees, the second a frequenter of
seashore.

In *Hesperornis* we see this adaptation to
aquatic mode of life pushed to its extrem
limit. From being a dweller on the seash
this bird has become a dweller on the
itself.

Possessing abundant food in the immedi
vicinity of a gently sloping coast-line free fr
violent surf, which served as a breeding-grou
and with the absence of enemies, flight beca
no longer necessary to existence, and was
changed for great diving powers. The sav
effected in the non-maintenance of the wing
an efficient organ of flight was applied to
increased development of the leg, upon wh
the powers of diving depended. To this e
other changes were also effected. Thus,
decline of the wing brought about the deger
ation of the breast-bone, by the complete l
of its keel. The wing itself became redu
to a mere vestige, only the upper arm-b
remaining; whilst the pelvis, or hip-girdle, beca
specially modified in accordance with the div
habits. Exactly what changes have taken pl

this part of the skeleton and its muscles
an only be appreciated by a comparison of
ne skeletons of say one of the modern divers,
nd an eagle or albatross, for the pelvis of
Hesperornis is scarcely distinguishable from
hat of the former, and differs from that of
chthyornis, as does the living diver from the
agle.

From this we gather that the distribution of this
ncient group—the divers'—was a moderately
ide one, and that some retained the power of
ight, finding it still necessary. From these have
prung our modern divers and grebes. The form
f the hip-girdle is exactly the same, both in
ving and fossil forms.

Hesperornis, then, was a highly specialised, or
ntensified water-bird, built for diving. We will
ow pass on to consider its opposite, the inten-
ified land-bird.

This we have in the gigantic moa of New
ealand which stood some ten feet or more in
eight, but other species existed, the smallest
f which was not much bigger than a large
urkey. They are now extinct, and are gener-
lly believed to have been exterminated for
ne purposes of food by the ancient Maories,
s the charred bones and egg-shells have been
ound mixed with charcoal representing the fuel
hich served to cook them.

This "intensified land-bird," as we have called
, is only one of many, but is selected for illus-
ration here because of the completeness with
hich this intensification has been carried out.

First and foremost it was flightless. The wing

remains a wing only so long as it is used
flight. As we have seen already, so soon
it ceases to be used for the purpose of flig
it more or less rapidly degenerates to a m
vestige, unless, as in the case of the pengu
it becomes transformed so as to perform ot
functions.

As we have shown in an earlier chapt
examples of flightless birds are numerous. H
the moa is perhaps the only bird that has carr
the process of suppression so far as to have l
not only all traces of the wing itself, but so
times of the bony girdle which supported it.

The rest of the skeleton bears out our fi
description of this bird as an intensified la
bird. In *Hesperornis* we find the hind-limb a
hip-girdle peculiarly modified for the purpose
swimming; in the moa the hind-limb and h
bones are just as obviously modified to ser
the purposes of walking and running.

It would be well here to take a brief surv
of the gradations in degeneration furnished
the wings of some living birds, probably close
related to the moa.

These are the rhea, ostrich, apteryx, emu, a
cassowary.

In these we have a series of stages in the d
generation of an organ. The wing of the Sou
American rhea most nearly resembles that
an ordinary functional wing, and we imagin
therefore, has most recently passed the sta
when it can no longer serve even as an org
for feeble flight. The wing, though large, is n
large enough to support the weight of the bod

Next comes the ostrich. As in rhea, the imary and secondary quill-feathers still per- t and retain their full strength in point of mbers. They are however too weak and ble to serve the purposes of flight. The w Zealand apteryx furnishes the next stage, ving greatly reduced the number of quill- thers, and the size of the wing. So dimin- ive is this last that it cannot be found thout careful search.

Lastly follow the emu and the cassowary. In th, primary feathers are greatly reduced in mber. In the former they have lost the stout quill" portion by degeneration, and retained e feathery vane. In the latter the "quills" ve become extremely specialised, and project yond the wing as huge spines, whilst the vane" has been thrown off. This is an in- resting example of the specialisation of a generate structure.

Not only then have the feathers in these birds generated, but the skeleton too shows every adation of decrease and decay by gradual sorption. We may gather from this the most absolute certainty that we are, in these ngs, studying so many stages in the decline of once functional organ—an organ of flight or, we call it, a wing. For additional and even ore convincing evidence we might turn to the atomy of the soft parts, *e.g.* the muscles. ese, we should find, were in every way ranged as in the birds that fly, proving, this disposition, that they have undergone similar adaptation to the mechanical require-

ments of flight. Even the very folds of sk
which invest these wings agree with those
birds that fly, and tell the same tale.

We may conclude then that though the wi
in the moa had completely vanished, or that
the *Hesperornis* was worse than useless, bo
almost certainly were not only descended fr
birds that fly, but once possessed this pow
themselves. A conclusion fraught with consid
able importance when considered in relation
the distribution of birds in time as we shall
presently.

For the purpose of illustrating the fact th
one organ may be developed at the expense
another, more clearly we may instance the sw
and the frigate-bird. These two, though not
the most remote degree related one to anoth
agree in this, that the wing has reached a co
paratively high grade of specialisation—thou
taking a different form in each—whilst the
has in both become so much reduced in size
to render walking a difficult process. In
swift they are so short that the bird can o
rise from the ground, should it alight there
with extreme difficulty. The powers of fli
possessed by these two birds are too well kno
to need description.

But what connection can all this have with
distribution of birds in time? Briefly this:
discovery of the fossils just enumerated sho
us that birds existed as far back as the Jura
epoch; but these same fossils are those of bi
which have reached a considerable degree
specialisation, or, as we sometimes call it,

ensification: and they must therefore be the scendants of less specialised, or, as we say, ore generalised forms, of which, at present, have no record whatever. Thus, far from pposing that birds had their origin in the rassic period, we must conclude that they d already appeared before this epoch.

The discovery of so extremely specialised a m as *Hesperornis* is one of deep significance, d shows that the divers must have been eady long in existence, possibly extending far back as *Archæopteryx* itself.

Moreover, we must guard against supposing, some do, that such and such a group of birds ust be descended from such and such a fossil. *sperornis* for instance is not the ancestor of modern divers, which so closely resemble it. form which had lost the power of flight so mpletely cannot have begotten offspring in ich the wing is fairly well developed. The esent divers are the descendants of *flying* ds. *Hesperornis* is a collateral branch of the ne family.

We shall see in the next chapter, wherein we ll discuss pedigrees, how intricate this problem descent is.

Closely connected with the question of the tribution of birds in time is their distribution space, or as we generally call it their "Geo-aphical distribution."

A moment's reflection will convince us that distribution of animals—whether birds, or asts, or fishes—is not likely to be influenced political boundaries, nor even necessarily

by those more ancient, and naturally circu
scribed areas which we know as continents a
islands.

Yet it is a fact that certain kinds of animals
using this word in its proper sense—are o
found in certain parts of the world. To con
ourselves to birds: We go for instance to Af
for secretary-birds and touracous, or to So
America for toucans and humming-birds. A
so we get a notion that the sharply defi
political distinctions, Indian, African, Chin
or European, are synonymous with real, nat
boundaries, each with its peculiar groups of bi
and beasts.

To a certain extent this is true. To
Sclater is due the credit of having first sh
us the real inwardness of this distribut
He proposed the recognition of six zoo-g
graphical regions, determined according
the nature of the bird fauna inhabiting
same. They are the Palæarctic, Ethiop
Indian, Australian, Nearctic and Neotrop
regions.

The Palæarctic region includes Europe, Af
and Arabia, north of the Tropic of Cancer,
whole of Asia, except India, Burma and So
East China, together with Japan, Iceland,
Azores and Cape de Verde Islands. The gro
pheasants, and capercailzies, long-tailed titm
robins, magpies and bullfinches are the charac
istic birds of this region.

The Ethiopian region includes Africa, sout
the Sahara, Madagascar and Arabia, south
the Tropic of Cancer. The ostrich, toura

lack hoopoe and secretary-bird, are some of e more striking forms it contains.

The Indian region embraces Southern Asia om the Himalayas and Yangtze River in China. s western limit has been defined by Dr Sharpe about 55°east longitude, where the Palæarctic id Indian regions find a frontier. Its most aracteristic birds appear to be the peacock and e broad-bill.

The Australian region embraces the Australian ntinent, and the islands lying to the east of a ne passing through the narrow strait between li and Lombok, called "Wallace's line." Of is we shall have more to say later. Its most oticeable birds are the emu, cassowary and the oteryx, birds-of-paradise, bower-birds, mega-odes, the lyre-bird and cockatoos.

The Nearctic region corresponds more or less ith the whole of North America and adjacent lands. It possesses so many features in com-on with the Palæarctic that many have sug-sted the blending of the two to form a Holarctic region."

The Neotropical region may be taken as presenting the whole of South and Central merica. The rhea, tinamous, opisthocomus, e guans, trumpeters, jacamars, puff-birds, hum-ing-birds, toucans, and many more combine to ve this region a remarkable interest.

Each of these different regions has been vided and subdivided into sub-regions and rovinces of varying extent. It would be im-ossible to discuss the relative merits, or even detail the boundaries of these in this little

work. Those who are interested in this fi
cinating subject should consult the works
Dr Sclater, Mr Alfred Russel Wallace, Pr
Newton, or Dr Sharpe.

The basis upon which these boundaries r
is their resident or non-migratory populati
For, besides which, there is a floating popu
tion, which periodically leaves one place
residence, often a high northern latitude,
another often not far removed from, or ev
within, the tropics. Concerning these migrato
tribes we shall have more to say later.

The study of the resident populations then—
birds or otherwise—of each of these gr
regions is one of extreme interest and impo
ance. Not because it tells us that such a
such a bird or beast is found in such and su
a region, but because we learn from it mu
concerning the past history of the earth t
would otherwise never have been suspecte
Zoo-geography may be regarded as a sort
hand-maid to geology.

For instance, when we come to study
fauna of the British Islands, and to compar
with that of the European continent, we fi
that the two are almost identical, though
further we get away, the more emphatic becom
the difference.

That the same species of birds occur in b
areas does not seem strange, for we know t
they can easily pass, what is to us an insurmou
able barrier, the sea that divides us from
continent. But what about the mammals
reptiles, the hare, the fox, the hedgehog

lger, the mice and squirrels, the snakes and
rds ?

Now here will come in the value of our study of
distribution of animals in time, showing us as
loes that the connection between the British
nds and the continent is still more intimate
n we at first suspected. For we learn now that
bear, the wolf, the reindeer, the wild boar,
beaver, and even the lion, elephant and
noceros, once roamed in both areas. The
ee last have disappeared more or less com-
ely throughout the greater part of what we
the Palæarctic region. The rest remain still
he continent but have long since passed away
n amongst the British fauna. But how came
of these to gain an entrance into these
nds ? One or other of them might have
ssed by swimming, but we can scarcely
pose all did. Our only other alternative
o postulate a former land connection. For
firmation on this point we turn to the
logist, and we are supplied with an abun-
ce of the most convincing evidence, which
l not be discussed here.

he distance of time which has elapsed since
isolated areas of land were last in connection,
gather approximately from the degree of dis-
ilarity in the fauna of each. Thus, when the
is comparatively recent, the differences are
ht; when of great antiquity, they will be
d to be very great.

or instance, as Mr Alfred Russel Wallace
ts out, the absence from Madagascar of al-
t all the characteristic mammalia, birds and

reptiles of Africa, shows that this island m
have been separated from the continent v
early in the period known as the Tertiary,
even earlier. This conclusion receives additio
testimony from the fact that Madagascar is stoc
with a very rich mammalian fauna, and
which presents many remarkable peculiari
Many of them are of a very lowly and arc
type.

The richness of its mammalian fauna pr
its former connection with the mainland; wh
the archaic character of this fauna shows
the connection must have existed during a v
remote period when the fauna of that por
of Africa at least, which was nearest the isl
was of a different and more primitive type t
the fauna now inhabiting this continent. T
primitive forms have disappeared from
mainland, and have given place to the m
specialised and vigorous types of to-day.
other island possesses so many peculiar
archaic mammalian forms; and no other is
on the globe, possessing a moderately
mammalian fauna, is separated from the m
land by a sea whose depth exceeds one thou
fathoms. What the great depth of this
teaches us will be shown presently.

New Zealand carries the record of re
isolation a step further. It possesses but
known mammals, and these are bats; and
one frog-like animal. Its reptiles and b
are very peculiar.

Now the almost entire absence of end
mammals would point to an isolation from

ainland—Australia—before the advent of even
e low mammalian types which characterise this
ntinent. The birds, reptiles, and flora of the
and are such as occur in Australia and the
jacent Pacific Islands, and suggest an origin
om these sources. They are a part of a fauna
d flora once forming a common area. It is
pposed, however, that the island has been
olated since the Cretaceous period.

Soundings show that the "sea which directly
parates New Zealand from Australia is more
an 2000 fathoms deep, but in a north-west
rection there is an extensive bank under 1000
thoms, extending to, and including, Lord Howe's
land; while north of this are other banks of the
me depth, approaching towards a sub-marine
tension of Queensland on the one hand, and
ew Caledonia on the other, and altogether sug-
stive of a land union with Australia at some
ry remote period." This suggested connection
made almost a certainty by the evidence con-
ibuted by the animal and plant life. The great
pth of the sea, as in the case between Africa
d Madagascar, together with the peculiarities
the fauna in each case, furnish then strong
idence that the period of isolation has, in
ch case, been one of great length.

We have one more instance of the significance
a deep sea between two adjacent land areas.
is is furnished by the Malay Archipelago. A
ne drawn between the two islands of Bali and
mbok divides the Archipelago into two dis-
ct zoo-geographical regions. The islands to
e west of this line belong to the Indian region,

those to the east to the Australian. The islan
lying on either side of this line lie in a shall
sea, and were doubtless connected, at no remo
period, with one another, and with the near
mainlands—Asia and Australia, with which th
respectively agree in the nature of the fauna a
flora. The width of the sea between Bali a
Lombok is only fifteen miles. Its depth is ov
1000 fathoms. These two islands are the e
tremest limits of two vast continents whi
formerly extended from Asia on the one ha
and Australia on the other. The contrast
the fauna is abrupt. In Bali, representing t
Asiatic continent, "we have," says Mr Walla
"barbets, fruit-thrushes and woodpeckers;
passing over to Lombok, these are seen
more, but we have abundance of cockato
honeysuckers and brush-turkeys, which a
equally unknown in Bali, or any island furth
west. The strait is here fifteen miles wide,
that we may pass in two hours from one gr
division of the earth to another, differing
essentially in their animal life as Europe d
from America. . . . The birds which are m
abundant in the western islands are the wo
peckers, barbets, trogons, fruit-thrushes and le
thrushes; they are seen daily, and form the gr
ornithological features of the country. In t
eastern islands these are absolutely unknow
honey-suckers and small lories being the m
common birds; so that the naturalist feels hims
in a new world, and can hardly realise that he h
passed from the one region to the other in a f
days, without ever being out of sight of land.'

The imaginary line drawn through the sea to erve as a boundary between Bali in the east, and ombok in the west, with the islands belonging o each, was called "Wallace's line," in honour f Mr Alfred Russel Wallace, who first pointed ut the significance of this barrier of deep vater.

So far, all the islands of which we have spoken ave been, at some time or another, parts of the earest mainland. The fauna and flora represent nore or less the fauna and flora of the mainland t the time when this particular portion became solated. The rocks will be found to be stratified, nd to agree in character with those of the main- and.

Other islands there are, however, which are f quite different origin. They are known as "Oceanic," as opposed to those just described which are called "Continental." An Oceanic island is either of volcanic or coral origin. At no time, therefore, has it ever formed part of the mainland. Its fauna and flora are peculiar, being derived from the nearest mainland, and carried thither by the wind, or from the flotsam and jetsam of the sea. The sea contributes such vegetable seeds as have hard shells, impermeable to salt water. These are cast up by the waves and often manage to find a root-hold on the shore; and such small mammalia as may have been conveyed on trunks of trees brought down from the nearest mainland by flood; or birds, as may have flown thither from some other island or continent.

The wind brings seeds of plants and

insects, often in great numbers, especially aft
gales.

As regards existing continents, it seems ther
is no good ground for supposing that their pos
tion, as a whole, has changed. In other word
the great ocean basins which divide them hav
remained the same for countless ages. It
true that each of the great continents may hav
suffered a sojourn beneath the sea, but this h
never been more than a partial submergenc
This has taken the form of denudation, or sul
sidence in one part, with a proportionate en
croachment of the sea, only to be balanced b
a proportionate elevation in some other part.

CHAPTER XI.

PEDIGREES AND FAMILY TIES.

AMONGST ourselves "blue-blood" and ancien
lineage, if not exactly "convertible goods," hav
undoubtedly a certain market value in the worl
of to-day. To have come of "a race of kings
is almost sure to procure for the proud descen
dant—where these things are appreciated—
certain deference that is never accorded his mor
obscure brethren, always provided, of course, tha
he shows himself worthy of our respect in othe
things. Nevertheless this same descendant may
in all things else, prove in no way superior to hi
obscurely born neighbours. In mental capacity
in energy and physique, he may even be inferio
In spite of this, his credentials are good, and h

gets a hearing. The feeling that lies behind all this is the same that prompts us in our distrust of strangers. We like references or letters of introduction when the individual claiming ought from us has no record or achievement of his own sufficiently notorious to supply their place.

If amongst ourselves "pedigree" is a marketable commodity, it becomes even more so when we descend to the consideration of our domestic animals, our horses, cattle and dogs, our fowls, pigeons, and so on. Here undoubtedly it is no mere sentiment but real worth that we pay for. The horse or the dog we buy that is thorough bred or pure-bred, as we call it, possesses certain qualities which his mongrel brethren have not. In each case the particular quality was present in their more or less remote ancestor, and was the cause of their being held in special esteem.

These thorough-bred or pure-bred animals we owe to the acumen and forethought of our forefathers, who, by carefully selecting mates most nearly approaching their ideal of perfection in certain points—say speed, or the quality of wool—gradually increased the desired property both in quality and quantity. This increase came about by virtue of what we call the law of heredity, the principle which causes an animal to resemble its parents; or, if you will, which causes an animal to produce offspring like itself. Thus, as we have already remarked, the young of a particular kind of bird or a particular kind of snake will reproduce all the peculiarities of form and colour which characterised its parents,

and by which they are distinguished from thei neighbours.

This process of creating new forms by modify ing old ones we call the process of "Artificia Selection." But, mark that whatever change have taken place have been changes wrought i already existing structures. There have bee no sudden introductions of structures hithert non-existent or foreign to their nature as—say pigeons. The rock-dove from which each pa ticular breed of pigeon is derived was alread a delicately organised, and highly specialise animal, so that any changes which could possibl be effected in its form must necessarily proce along certain lines by the exaggeration of a ready existing structures. It would have bee impossible for instance to change it into a for resembling a hawk or a crow.

It sometimes happens with the pedigrees o distinguished people that the further back w trace their ancestry, the more humble an obscure does it become. So is it with anima and plants. The exact manner in which the have come by their present forms, and wha their ancestors were like, is the puzzle whic men of science are trying to unravel. Th machinery which has been largely responsib is at work all round us, and has been going o since the beginning of living things.

> "For though the mills of God grind slowly,
> Yet they grind exceeding small."

We are daily sifting these fragments in t hope of finding now and again a few that will

together and make a whole, cracked and with bits missing it may be, but yet showing us enough to give hints of new lines of research.

Till comparatively recently—within the present century—the outcome of this collection of fragments seemed but a lumber-room of useless facts. True, some sort of order had been introduced, but no system or intelligible explanation had been given. When Charles Darwin began to inspect this lumber-room he discovered it to be in reality a vast treasure-house, and he immediately set about collecting more material to fill up vacant spaces and missing gems. The result of his labours has revolutionised modern thought. His interpretation of these isolated facts and of the motive power behind them he gave us in what we now know as the theory of natural selection or descent with modification.

An enormous amount of work yet remains to be done. He gave us the key to what before were but hieroglyphics. We are now all engaged in doing our best to translate. Alas, many essay the task before they have learnt the language, and many work badly, the best of us but slowly, still knowledge is gradually growing.

We are hunting now amongst the records of the past to find pedigrees for the living and the dead. This we can only do by collecting evidence of every possible description. Much of it is derived from inorganic nature—floods and earthquakes, cold and heat, wind and rain. Thus we learn how forms no longer represented in the life of the globe, struggled and failed and

died in their endeavour to overcome these vicissitudes, so the dead point to the living to show by what means they have managed to survive. The living are the adaptable descendants, who have succeeded in shaking off certain of those family traditions and family idiosyncrasies which stood in the way of advancement, or even of continued existence. Advancement followed as a result of ability to obey. Thus we get the evolution of a species.

It must be mentioned here, however, that it becomes a very difficult matter to say exactly what is a species. It is obvious that if a species is the outcome of a gradual change from one form to another, from a short to a long-billed bird for instance, then if we had every member in the series alive before us, it would be impossible to say where the short-bill species ceased and the long-billed began. Yet the lowest and the highest members in the series would be easily distinguished. The "species" living at the present day are isolated links in such a chain of individuals, recognisable as distinct because they *are* isolated. Similarly we know that if we had many of the extinct forms for comparison, the differences between the principal larger existing groups would fade away; and we should have a difficulty in saying, for instance, where the lion begins and the ox ends. For strange as it may seem to many, we have enough evidence to prove that the carnivora and the herbivora are traceable to one common ancestor.

With the birds, if we could go far enough back, and if we had all the links in the chain,

we should have a difficulty in distinguishing between the reptile and the bird.

Furthermore, we shall see that evolution is not always *progressive*, on the contrary it is sometimes retrogressive. We shall also learn something of what we may call the law of correlated variation.

Concerning this Mr Darwin writes, "In man, as in the lower animals, many structures are so intimately related, that when one part varies, so does another, without our being able, in most cases, to assign any reason. We cannot say whether the one part governs the other, or whether both are governed by some earlier developed part." Thus, pigeons with feathered legs have the outer toes webbed.

Let us turn now to the question of the birds' pedigree, and, so far as is possible, trace out their relationships one to another.

The oldest bird of which we have any record is that known as the *Archæopteryx*, meaning the ancient-winged one. It is sometimes called the lizard-tailed bird. The figure (p. 207) is a restoration made by the writer, and is based on a study of the fossil in the Berlin and London Museums.

All that we know of this bird is gathered from the remains of two fossils found in the Solenhofen Lithographic Stone of Eichstadt in Bavaria. The first of these was discovered in 1861, and is now in the British Museum. The other was found in 1877, and it rests in the Berlin Natural History Museum.

In the London specimen the hind-limb and tail only are really well preserved; whilst, in the

Berlin specimen, the head, pectoral girdle, and the wings, are beautifully preserved; so also is the tail.

This tail, as is well seen in the figure, is the most remarkable feature of the whole bird. It is like that of no other bird known. But it exactly resembles the tail of a reptile. It is of great length, and composed of a number of separate vertebrae, each of which supports a pair of long tail-feathers.

This method of disposal of the tail-feathers is found in no other known bird, fossil or living. The accompanying figures show the nature of the two different forms of arrangement. Fig. A shows the tail of *Archæopteryx*; fig. C, that of modern birds. In *Archæopteryx* the feathers are distributed along the vertebrae like the arrangement of flowers along a stem, to form what is known as a spike. In other birds they are clustered around a common centre, as in a composite flower. The tail has been telescoped, as it were, so as to cause the bases of the feathers to cluster together, or to radiate from a common centre.

The possession of teeth in the jaws is another reptilian character, but, as we shall see, birds retained these long after they had changed the form of the tail. Finally, the teeth disappeared.

The wing of *archæopteryx* differed from that of all other birds in that the third digit was armed with a claw, as also were the thumb (or first digit) and the first finger (or second digit). Claws on the thumb and index finger occur frequently in birds of to-day.

The pelvis or hip-girdle was distinctly reptilian
n type, as also were the ribs of the neck verte-
brae, and those along the abdomen.

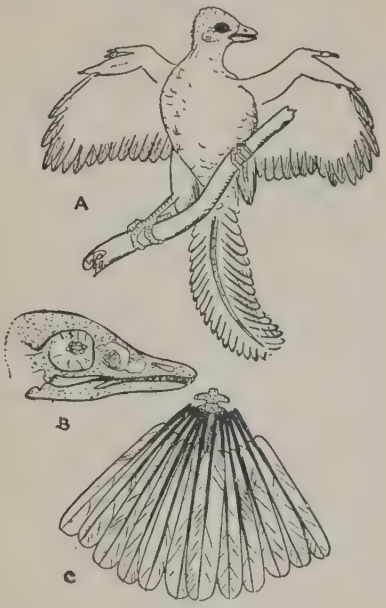

Fig. 4.

A.—A restoration of the extinct bird, archæopteryx.
B.—The head of archæopteryx.
C.—The tail-feathers ranged about the skeleton as in modern birds. Contrast this with the arrangement which obtains in archæopteryx.

In every other part of the skeleton it was dis-

tinctly bird-like in type. Nevertheless many these bird-like characters undoubtedly bespeak reptilian origin.

In many points *Archæopteryx* and the embr or nestlings of modern birds exactly agree, a both point to a more generalized ancestral ty The two most important of these differences a concerned with the skeleton of the wing and l

We have reason to believe that both the limbs possessed at one time five digits a-pie Gradually two of them vanished from the wi and at least one from the foot. In the adu of modern birds the three bones of the midd hand, called the metacarpals, are all so complet blended as to give the impression that they ha all been cast, as it were, in a single mould, whi the three bones that go to form the middle bo of the foot, or metatarsals, are welded into single solid shaft, without betraying the sligh est indication that they ever were distinct. the young bird, however, this shaft is travers by three fine seams suggesting that origina there were three separate bones. In the st younger bird or embryo, not only do we fi these bones actually separate, but we get eviden of there having been as many as *five* digits, as the reptilian foot. The fourth exists in ma living and fossil birds as the hallux or hind-to No bird, living or extinct, is known in which t fifth toe is present. The fifth toe of the Dorki fowl is simply a double hallux or hind-toe.

In the wing, as in the foot, in the young bi the three metacarpals, so completely welded the adult, are distinctly traceable as separa

ones. In the embryo they are undoubtedly parate.

In the wing of *archæopteryx* fusion or welding these bones was probably never *completely* fected, a trace of the separate elements always mained. We say probably, because there is thing to show conclusively that the two fossils *archæopteryx* were really those of perfectly ult birds.

It is extremely significant that the form of the ing and leg of a bird so ancient as archæopryx should so closely resemble those of modern rds. The wing-bones differ only in the great ze of the claw of the third digit, for a minute aw has been found in the wing of the young trich. The leg is apparently in no way culiar. Hence we must wait for the dis-very of a yet more ancient bird before we n find out *exactly* from what form of a hand d foot the present has been evolved.

The possession of feathers so perfect in their velopment is also wonderful. It shows us that cient as is this fossil, we must go yet further ck in time for a hint as to the beginning of ese feathers. The wing-feathers in their mber and development are as complete as many living birds, while their form and size ould indicate that the power of flight was ited.

The possession of a permanent claw on the third git has been a great stumbling-block to many ho have studied the fossil. It was taken for anted that its presence was a proof that the hole hand was used in climbing among the

trees or in crawling about over the grou
That, in short, progression was quadrupe
and not bipedal. That the wing as an or
of flight was useless: it served as a parach
and nothing more.

As a matter of fact, this claw was proba
functional during the nestling period in the
of the bird, enabling it to climb before
feathers grew long enough to serve the purp
of flight, and also during the process of moult
after the bird had reached maturity. At t
time it is possible that all the feathers of
wing were cast off at the same time, and u
the new ones were sufficiently strong, fli
would be impossible. The ducks to-day m
in this way, and for a season swimming
walking are their only means of locomoti
The nestling *opisthocomus*, a strictly arbo
bird—as was *archæopteryx*—uses its wing
climbing purposes, and is aided in this by cla
which however are absorbed as soon as the w
is capable of sustaining the bird by flight.

The disappearance of these claws is instruct
It is a link in the chain of evidence upon wh
the recapitulation theory is founded. In a gen
way, this means that an animal in the course
its development from the germ upwards repe
the main phases of the development of the r
to which it belongs. Structures which no lon
appear in the adult or young after birth pu
an appearance for a longer or shorter time dur
embryonic growth. Thus oxen and sheep wh
have no cutting, or incisor, teeth in the up
jaw, have tiny ones which never cut the gum

ie embryo. Whale-bone whales have no teeth, xcept in the embryo where small ones are re-ognizable, yet small teeth appear in the embryo. The size of these vestigial teeth bears some roportion to the time which has elapsed since ey were useful. They grow less and less as ie time since they were useful grows greater id greater, till they finally cease to record iemselves any longer. It is as if these struc-res were originally endowed, so to speak, with certain amount of material set aside for their pport. So long as they were used this capital endowment gained interest, as soon as they ased to be used the interest stopped and the pital slowly vanished.

In the bird's wing we have a good illustration this. The rails are birds of feeble flight and nall wings, which in some have become so small to be rendered useless; in the apteryx they e so tiny as to require a careful search to find iem; in the old fossil *Hesperornis* only the upper m-bone was left, and in the moas even this dis-ppeared. The first in time to become flightless ere the moas, the last some species of rails. In ie flightless species the wing is developed in very young one that is born; but in every oung one it is probably a shade smaller than its parents, and so it will go on dwindling in ch generation, at last appearing only in the nbryo, and finally disappearing even in these.

The claw on the third finger of *Archæopteryx* as very probably only used by the nestling, nd perhaps also by the adult during the moulting eriod. Soon the adult learnt to moult his quills

in pairs, as is done by most birds to-day. T
usefulness of this claw would at once begin
decline, and its size would begin to decrea
Then it would tend to disappear as soon as t
nestling period was over. Then even the nestl
would manage to dispense with it—as do m
modern birds—and it would appear for a time
a tiny vestige; at last it would crop up only
the embryo, and here in time it would vanish t
We can trace all these gradations in the devel
ment of modern birds. It is a long time si
the nestling game-birds climbed about in trees,
that the claw has nearly ceased to exist; it appe
for a short time in the embryo. The pecul
order of the succession of the quill-feathers, h
ever, is still retained as we have already sho
on p. 206. Thus when we suspect that an ani
has lost such and such an organ, still posses
by its fellows, we look for it in the nestling
the embryo, and generally with success.

The next most primitive type that we have
that to which the ostrich, rhea, cassowary, apte
and emu belong. They are generally grou
together under one head as "ratites," beca
they have a raft-like breast-bone, but this
rangement is rather one for convenience' sake.

Concerning this breast-bone you will remem
that we have already pointed out its chief d
tinctions (p. 72). We need only say here that
the ratite and the stringops-parrot there is
"keel" running down the middle of the brea
bone as there is in all other birds. The brea
bone of the fowl or pigeon looks rather like t
wide and shallow hull of a ship with a huge ke

iat of the ratite, from the absence of the keel, oks like a raft.

A much more important character for the pur- ose of tracing relationships is the method of rangement of the bones of the palate.

The long since extinct *Æpyornis*, and the moa, easured by this test are seen to be related one to nother, and to the living emu of to-day. More- ver these and the tinamous can on this account e separated from all other living birds.

The number of the toes varies. In the *Æpyornis*, ne moa and the apteryx, there are four—a hind- oe and three front ones. In the cassowary, emu, nd rhea, there are only three, the hind-toe being bsent. In the ostrich there are only two, re- resenting the third and fourth. In the young strich the second metatarsal bone, for the sup- ort of the second but missing toe, is present; ut all trace of its distinctness is lost later, and helps to form the common shaft of the leg. he toe is never developed. There are other natomical points which show that these birds re related, but they need not be dealt with ere.

The tinamou, a South American game-bird, is pparently somewhat closely related to the rhea f the same region. The arrangement of the ones of the palate is precisely similar. The hip- irdle is also of the same type. The down which lothes the nestling is however quite different, iffering indeed from that of any other bird.

Here we come to another break. It is im- ossible to do more than guess at the next earest allies of the "ratitæ." The game-birds

certainly come very near. Such are the jung fowls, pheasants and partridges, grouse, quai francolins and curassows, for instance.

It is interesting to note here that it is t red jungle-fowl from which all our breeds domestic poultry are descended, though some these varieties would scarcely be recognised such, the Polish, Cochin-chinas, and rumple fowls being extremely modified types. One the japanese fowls has the tail feathers develop to an enormous extent, in some individuals to much as fifteen feet.

More or less close allies of the game-birds strange as it may seem—are the ducks, gee and swans. The apparent incongruity of su an alliance is however much lessened when come to study what may be regarded as the a cestral form from which the rest have sprung.

This is a South American bird known as t screamer (*Palamedea*) which in size, about equ a turkey.

In many respects this bird may be regard as a connecting link between the game-bir and the duck and goose tribe of which it undoubtedly a member. Its skull is very li that of a game-bird. The feet, unlike all t other members of the goose-tribe, are not webbe though in spite of this the bird is a power swimmer. Its wings are armed with power spurs and in this it differs from the game-bir and the remainder of its own and closer alli Some of the habits of *Chauna*, another memb of the same family as the *Palamedea* or horn screamer, have already been described (page 9

Another ancient form allied to the geese is *stornis*, an extinct goose-like bird larger than ostrich.

Next under consideration must come a series forms, all of which are probably more or less arly allied. They may be divided into about ur great groups as follows :—

(1) The gannets, cormorants, darters, frigate-rds, pelicans and boatswain birds, (2) the storks d herons, ibises and flamingoes, (3) the hawks, gles and vultures, and (4) the cranes, rails, overs, gulls, auks, pigeons and sand-grouse.

The birds-of-prey seem to claim affinity with e crane-tribe on the one hand, and the stork-ibe on the other. If they had a leaning more ie way than another perhaps it is towards the orks. Amongst other things, like the storks, ey nest in trees rather than on the ground, id their young are for a long time helpless. ome doubt whether the vultures of America hould really be included amongst the birds-of-rey at all, holding that they are really much ore closely allied to the storks.

The most aberrant bird of prey, after American ultures, is the secretary bird of Africa, which, nongst other things, has acquired legs of great ngth. The Osprey was once supposed to re-mble owls in some respects, and on this account as regarded as an aberrant type connecting owls id hawks, but it is now certain that it has no ffinity whatsoever to these.

The typical cranes scarcely need description. et, many constantly confound the common heron f our river-sides and marshes with the crane.

An excusable mistake, it must be admitted, there is a superficial resemblance.

The crane group contains many curious a puzzling forms, such as the trumpeter, the s ema, and the sun-bittern of Central and So America. The seriema, in many respects, sembles the birds-of-prey.

Of the rails many have become flightless, su are *Ocydromus*, the wood-hen rail of New Zealan the *Cabalus* of the Chatham Islands, and *P zanula* of Laysan.

The little water-hen, so common in the Lond parks, is a rail. One of the giant members of t group is the notornis of New Zealand, which w first described, from some fossil bones. Late living bird was seen and killed, when the spec was found to be flightless. Only a few mont since a third specimen was shot.

The plovers contain many curious forms, so of them, such as the jacana, being hard to d tinguish at first sight from rails. The dotter sandpipers, curlew, snipe and woodcock, belo here. The lapwing of our marshes and meado lands must be familiar to most. Every spri large quantities of its eggs are bought by gree and thoughtless people as an addition to number of other luxuries to be had only at t expense of those helpless ones claiming prot tion from us.

Near the cranes and plovers stand the bustar Of these the largest is the great bustard, at o time numbered amongst British native birds, b now, alas! extinct in these Islands.

There can be no doubt but that the gulls a

erns are very close allies of the plovers. They are younger scions of the same stock. The difference in the colouration of the plumage of the young and adult plover is slight, or non-existent. The difference between the nestling gull and the adult is very marked. Like the more ancient plovers, the young gulls are clothed in a brown livery; in some, as in the common black-headed gull, so frequently seen even near London Bridge, this gives place to the familiar pure white and pearl-grey after the first moult; in others, as the great black-backed gull, it takes three years to gain the adult dress. In the little black-headed gull, both male and female, on each spring a sooty black hood, which is lost directly the breeding-season has passed; but the black-backed gull has no seasonal change of plumage.

The auks, razor-bills, and puffins of our coasts have been most persistently thrust in amongst the grebes and divers, and labelled as their cousins. This was done merely on the strength of a superficial resemblance, which doubtless exists; but those whose business it is to do the work of the heralds' college, and search the records of the past, are now in a position to demonstrate the falsity of such a view, and careful dissection of these birds has proved beyond cavil that they stand very near indeed to the plovers.

It is not so easy to say which are really the nearest relatives of the pigeons and sand-grouse. Some place them near the game-birds, and some regard them as the latest descendants of the plover-tribe. Their pedigree has yet to be

made out. The young of the sand-grouse a
like little animated balls of fluff; those of t
pigeon are hatched blind and naked, and are
most covered only with a few straggling hair-li
filaments, but this is a point of some significan
and shows the pigeon to be the more recent
developed of the two.

The tracing of these pedigrees has brought
out amongst forms of comparatively recent d
velopment—as pedigree times go. We ha
now to turn back again into the misty past, a
start afresh with forms undoubtedly ancient, b
whose records for the time are hidden.

The most aberrant, or outlying group among
these, is undoubtedly that of the penguins. T
most remarkable feature of these birds—and
is remarkable—is the wing. This you will r
member we discussed on p. 82. The penguin
play the part of the divers of the souther
hemisphere—strangely enough, they are confin
to this region never having passed the equator.

Very near the penguins stand the petrels a
the divers, which probably originated from so
stork-like ancestor, since they possess many cha
acters in common apparently only traceable
such a source.

The petrels, or at least many of them, a
claimed to be amongst British birds. Such a
the Mother Carey's chicken, Leach's petrel, a
the Manx shear-water which breeds upon lone
St Kilda, and elsewhere along our shores. T
albatross has been found in Britain, too, but on
in a fossil state. The petrels contain one strang
diving-form, called the diving-petrel; in whi

ich of the skeleton has been completely but adually changed in correspondence with the anging habits of the bird. Some of the petrels crete great quantities of fat, so much so, that e natives of the lonely spots where they breed read a wick through their dead bodies and urn them like lamps.

The divers are the expert fishermen of our as and lochs, as the grebes are of our lakes d broads. Like the diving-petrel, and the auks d guillemots, this group has undergone a great ange in the form of the skeleton. The legs ve shifted far backwards, and developed ecial process to give power to the stroke swimming. The divers have become so ghly specialised in this direction that they n no longer walk upon land, but simply push emselves along on their breasts by means their feet. This similarity in the skeleton these really very different forms at first led any astray, since they mistook what is really it the result of similar habits and environment r a record of characters acquired by descent om a common ancestor.

Again we must hasten back to more ancient rms: this time to the vicinity of the game-rds and the crane-tribe.

These two groups are considered by many of the est authorities to be somewhat nearly related.

Now the bird of which we are going to speak as long been a puzzle to ornithologists, and con-nues to be so to this day. It is known as the oatzin or opisthocomus, and is a native of the mazon Valley.

By some it is regarded as a very aberra
game-bird; by others as more nearly allied
the rail-tribe. Others incline to consider it ve
near the game-birds, though sufficiently distin
to be regarded as representing a group in itsel

It has yet affinities in another direction, a
these, if followed up, will lead us to the m
highly-developed members of all the birds—t
perching-birds or passeres.

Granting, then, its undoubted claims to k
ship, not only with the game-birds, but m
remotely to the rail-tribe, let us follow up t
new trail.

The first new group which we come to in t
direction are outlying members of a series
forms which stand more or less closely relat
one to another, and distinct from all the re
of the birds. They are the plantain-eaters
touracous of Africa. Opisthocomus serves
the connecting link between them and the
congeners and the game-birds.

From the touracous we pass to the cuckoo
from thence to the hornbills and hoopoes; a
then on to a group including such forms as t
rollers, bee-eaters, mot-mots, and puff-birds. Th
brings us to the magnificent trogons, and t
curious little African coly or mouse-bird.

Now we come to another group of vari
forms all closely related. Such are the barbe
and honey-guide, the toucans and the woo
peckers.

Before we take the last group of all, we w
turn back to survey a few other groups passe
in following up the foregoing.

These are the parrots, the owls, night-jars, ifts and humming-birds, and the kingfishers. All these, it is commonly admitted, are more less closely related, although they have never fore been quite so intimately associated. I ve arranged them in this sequence with a rpose. All agree in one particular, which, ough an apparently trifling one, is yet pro-bly important — all are gap-winged forms. ou will remember that, on p. 67, we pointed t that a gap-winged bird was one in which e fifth pair of great or, as we might say, eatest coverts of the forearm differs from all e other coverts of that series in that they abrace no quill-feather, which all the others do. We said *all* agree. This is not *quite* true, be-use humming-birds, some of the kingfishers d swifts curiously enough do not seem to be p-winged. Recent researches on this subject, wever, have shown that in some birds—the geons—this pair of covert feathers gradually vindle in size till they come to look like the verts of the row next above, and thus till tely not only have escaped notice but have ade the wing appear to be non-gap-winged. ow, when we come to study the wings of these ceptional kingfishers and swifts, we shall find ey will tell the same story. They will only *pear* to have no gap, or they may even in me cases have quite lost it. But this will not atter; they belong all the same to the gap-inged type.

Having got this little coterie of gap-winged rms cut off from the main body of this large

group, the difficulty is to throw back far enou to find the branch from which they sprang.

We now come to the last group of all, name the passeres, as they are called. To this belo our song-birds and the majority of our ca birds; the swallows and martins, flycatche tit-mice and nut-hatches, and so on. The pro position of the head of the house is accor to the crows, by consent of the majority naturalists. Some would replace them by t thrushes, others by the larks.

Into the respective merits of the vari claimants we need not go here. They w be found discussed elsewhere.

Outlying members of this passerine group the lyre-birds and scrub-birds of Australia, a the broad-bills of the Indo-Malayan countri The points which exclude these from the c fines of the main group are concerned with t voice muscles and on this account are of t technical a character to be discussed here.

The grouping together of the different kin of birds according to what we believe to be th natural relationships constitutes what we c the classification of birds.

We might summarise this chapter as follo Birds may be divided into two main divisions

1. Lizard-tailed, including, at present, arch opteryx only.
2. Bird-tailed, including the remainder the class. This last must be again s divided into many smaller groups, thou how to separate them without violence not easy.

Taking the ostrich-tribe as our starting-point, nd as the most ancient forms of the second vision we pass on by means of the tinamous, hich serve as a connecting link, to the game-rds.

From the game-birds we pass to the ducks and eese and their kindred, through the curious aber-nt forms *Palamedea* and *Chauna*—p. 214.

The stork-tribe follow next, including the annet and cormorant-like birds. We pass om these to the hawk-tribe, and thence to ie crane-tribe, with the rails, plovers and geons.

In the neighbourhood of the stork-tribe come ie penguins, the petrels and the divers.

Turning to the vicinity of the game-birds again, e come to the opisthocomus, and pass from this timately to the highest groups of all. On the ay we encounter the touracous and cuckoos, ornbills and hoopoes, rollers, and so on through ogons, rollers, and many more, to the wood-eckers, and from thence to the passeres, the ghest group of all.

The gap-winged parrots, owls, night-jars and vifts, and the kingfishers, are more closely related ne to another, than to the non-gap-winged forms ready referred to.

On account of the remarkable gap-winged con-tion of these birds it is probable that they must e regarded as branching off low down the avian ee from the galline stock, possibly from an ally the megapodes (p. 146), just as the kindred rms do from that other aberrant game-bird, ie opisthocomus. They bear no such direct

relationship to the passeres, as say the hornbi and hoopoes, or the rollers or woodpeckers.

One word more, these various groups do n permit of arrangement in linear series. They a *not* related one to another like so many steps i ladder. As we have shown in chapter X. speaking of the old fossils *ichthyornis* and *hesp ornis*, the evolution of two quite different for may be going on at one and the same tim Rather, the scheme of evolution should be garded as tree-like. The existing species may regarded as the leaves thereof—the fossils bei the branches from which they have derived istence. Our endeavour is to trace these lea back to the newly formed twig, and this ba to the branch, the branch to the main stem, a this to the root. Finally, we have to analyse t soil in which the tree is rooted.

CHAPTER XII.

PEDIGREES—THE FOUNDERS OF THE HOUSE

If a bird could tell us of its ancestry and of ancient lineage, of the stock which gave bir to its distinguished house, it would have to l aside all "pride, vain-glory, and hypocrisy," a put on the garment of humility. For, howev distinguished now, its origin was lowly.

The birds are a branch of that more huml house of interesting, but ugly, people—ugly, least, by comparison—yclept reptiles.

Two claimants have been pushed forward

presenting the stock from which the birds rose.

The first of these is that remarkable group of extinct flying reptilia known as the *pterodactyles*, ne wing-fingered lizards, and there is certainly uch to be said, at first sight, for the probability f an alliance with these. The structure of the kull favours this view most. The power of ight and the fact that the bones were pneuatic have also been urged as valid reasons or this relationship.

We may take the wing, I think, as the crucial est, and upon the likeness of this to that of the ird the whole claim must rest. To bring out ne full significance of this we will enlarge upon ur remarks in chapter IV., and endeavour to now, by comparison, how the wings of the terodactyle, the bat, and the bird, are all odifications of one common type — a five-ngered hand.

In the wings of all these it is the fingers, or nore exactly the hand, which have undergone he greatest changes in this transformation into he wing.

In the pterodactyle all five fingers are reained. The first four, however, are greatly educed in size. Three of them are provided vith small claws, and probably served to susend their possessor to some rock or tree during est, just as the bat to-day hooks himself up by he tiny toes of his hind-feet. The fifth, or little, nger was enormously developed, and served as support to a membrane formed by a drawing out, so to speak, of the skin of the body.

Exactly how this was done, and what this wi was like, can be seen by a reference to o picture (fig. 5).

Fig. 5.

A restoration of an extinct flying lizard or pterodactyl By the author.

The bat's wing differs from the pterodactyle in that all five fingers are well developed. Th thumb in some species is very long and arme with a powerful claw. The four fingers a exceedingly long and slender, and support thin membrane much after the fashion of th ribs of an umbrella.

Now compare these two with the wing of th bird. Let us begin with the skeleton. At th first glance this will appear to have but one ver short finger—representing the thumb—and on very long one, representing the index or fir finger. If we look at this closely in a ver young bird, we shall find that this long fing really consists of two fingers closely joined t gether, representing the second and third digi

our hand. This third digit is in modern birds
ry short, but in archæopteryx it was long and
ned with a strong claw. Now, these two

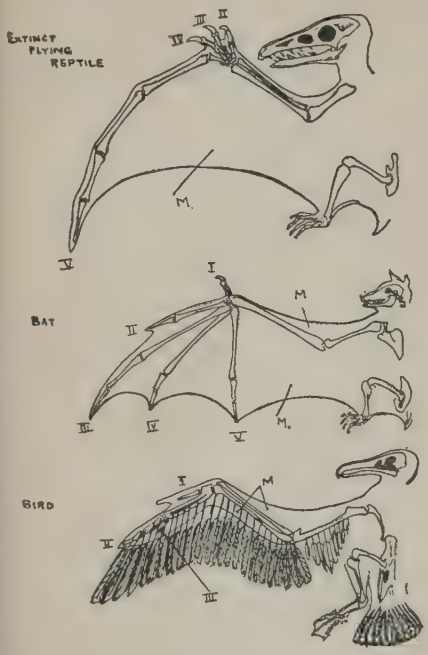

FIG. 6.

Outline figures showing the two different types of
g-membranes (*m.*) and their supports, contrasted
th the feathers of a bird which take the place of
nbranes. The membrane of the bird has shrunk to
ly slender proportions.

closely-applied fingers form a sort of rod
bar, continuous with the bones of the forearm
Along this is found not a large, thin membran
stretched between the wing and the body, as
the bat, but a marvellously arranged series of st
feathers which we call quill-feathers. The
are so arranged that they let the wind pa
through the wing on the upstroke, but oft
an unyielding, sail-like surface on the dow
stroke, and thus make flight possible. Y
will thus realise at once the great difference
the mechanism by which flight is effected in t
pterodactyle and the bird, a difference so gre
that we cannot well imagine the one form
wing to have been derived from the other.

The other claimant urged upon us as the m
probable ancestor, is the house that culminat
in the unwieldy dinosaur. That is to say, t
bird and the dinosaur both derive their origin
all probability from the same stock.

We rely for our evidence more particula
upon the curious similarity of the hip-girdle a
the hind-limb, the similarity of these limbs in t
two forms being very striking: whilst the liken
of the shoulder-girdle of each is scarcely less s

Let us compare the shoulder-girdle first.

In the bird we have a long, curved, r
like bone, the scapula or blade-bone; this re
upon the ribs. One end is directed tailwar
and is free; the other, which is directed dow
wards and forwards, joins a second but oft
shorter bone, the coracoid, as it is called.
these is added the furcula or merry-though
the free ends of this are fixed by ligaments

nds, to the region where the scapula and racoid join one another. The fixed ends of is merry-thought, the apex of the "horse-shoe" hich the two fixed bones form, is joined by gament to the deep keel of the breast-bone. n flightless birds there is often no keel and merry-thought, but this does not affect the estion.)

These bones, then, the scapula, coracoid and rcula, make up the shoulder-girdle.

Now, here follows a point to be borne in mind r future guidance. In young birds all these nes are represented first in what is called rtilage. Later this is replaced by bone. Exctly how this is done does not concern us here. his transformation from cartilage to bone is ot effected all at once. In the penguin, for stance, the shoulder-girdle becomes bony, or ssifies, long before the breast-bone or sternum. ow, if one of these birds died during this stage its growth and became fossilised, we should ave no record of the sternum left. It would ecay with the fleshy parts, and only the houlder-girdle bones would be left.

In the ancient dinosaur, we get a shoulderirdle bearing many strong resemblances to that the bird. As the dinosaur is not a flying eptile, we cannot expect it to do more than *roughly* resemble the birds. The dinosaur then as modified the original shoulder-girdle in one irection to suit its requirements, and so has hanged its original form, just as the bird has hanged its shoulder-girdle to suit yet other requirements. Neither then represents the original

girdle, but as the dinosaur has undergone le change or specialisation in this region than t bird, we may infer that the dinosaur's girdl more nearly approaches the original clay fro which each was modelled, so to speak.

The scapula and coracoid certainly in th general form and arrangement resemble the bird But we get no merry-thought, and no sternu The former may have been lost, as it is in sor birds; the latter was probably never ossifie but resembled that of the young penguin being cartilaginous and was, therefore, not pr served. In the penguin it ossifies late in life, the dinosaur not at all. The large size and nu ber of the ribs in the dinosaur make it certai that such a sternum once existed, for it is th structure to the sides of which the ribs a attached. The figures should make this clear

Turning now to the hip-girdle, we note equal important points of resemblance, but upon the d tails of these we will not enlarge here. The chi points of difference appear to be in the gener outline of the largest and uppermost of the thr bones of which this girdle is made up—and the greater size of the small forwardly projectin spike of bone called the pectineal process. the bird this is never very large; but as we sa before, we must not expect too close a reser blance. Indeed a *very* close resemblance wou rather prove too much.

In the form of the hind-limb again, we ha one or two curious points of resemblance, th would seem to imply kinship rather than sim arity of structure produced by a similar mode

comotion. Compare, for instance, the ankle-
int of a dinosaur with that of a young fowl,
. 7, and then the bones of the foot in the
me.

Note in the dinosaur the curious upright spike
bone marked "a.a." This is an upstanding
ocess of a bone known as the astragalus. More
nes were really originally present in this
gion of the foot, but they have all fused or
mbined together to form one—once on a time
ey were distinct. Capping the bundle of three
nes immediately below is seen a plate-like
ructure which represents a second row of bones
one time quite distinct. The joint, or seat of
ovement between the foot and the leg, lay be-
ween these two rows of fused ankle-bones.
urn now to the bones of the young fowl's foot
nd leg and ankle-joint, and a precisely similar
rrangement will be seen. The fowl, however,
oes a step further. The three long bones of the
ot, permanently distinct in the dinosaur, be-
me completely merged together in the adult
wl to form but a single shaft. An ankle-joint
uch as that just described occurs in some other
eptiles, and in *all* birds.

These are the principal points of resemblance
etween the two, but they are points of very
reat significance.

The fore-limb, someone will exclaim, is very
ifferent in this old reptile and the bird. Quite
o. Like the shoulder-girdle, it has in the bird
ndergone considerable modification and trans-
ormation to fit it for the purposes of flight.
The fore-limb of the dinosaur has required no

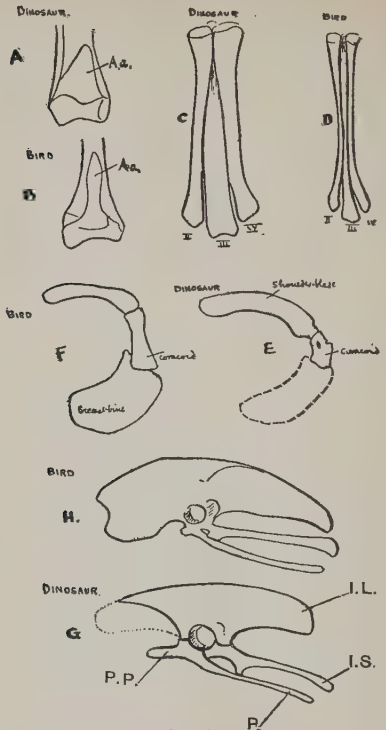

FIG. 7.

A.—The upper part of the ankle-joint of a dinosaur and B of a bird to show their similarity.

C.—The metatarsal bones of a dinosaur, and D of a bird to show the close resemblance.

E.—The shoulder-girdle of a dinosaur and F of a bird; G the hip-girdle of a dinosaur, and H of a bird. Note the remarkably close similarity between these bones of the bird and of the dinosaur.

:h alterations, and retains something like the ginal five-fingered form from which it started. The bird then we have agreed is of reptilian gin, and of the reptiles resembles most nearly dinosauria. Most nearly—this implies that nas also characters wherein it resembles other otiles; and so it has. Of these we will now ect a few examples.

Let us take the skull. In this, in many otiles, we find true teeth. These are either planted in the jaws in grooves or in sockets. the earliest birds—*Archæopteryx*, *Hesperornis*, d *Ichthyornis*—we have also teeth in the jaws. his would suggest that the birds come from reptilian stock possessing teeth. They were planted in sockets in *Archæopteryx* and *Ichyornis*, and grooves in *Hesperornis*. The erodactyles had teeth, but some of the more ecialised amongst them exchanged these for orn-encased jaws like those of our modern rds.

The skull, in all existing reptiles and birds, joined to the vertebral column by a single unded knob called a condyle. In the class ext below the reptiles, to which the frogs and ads belong, and in the class next above the rds, the mammals, the skull joins on to, or rticulates with, the vertebral column by two ondyles, arranged pairwise instead of a single edian one. But besides these we find in the kull numerous other points shared in common etween the bird and reptile which are of too echnical a nature to be dealt with here.

Birds and some reptiles, but no other animals,

have curious spine-like processes projecting bac
wards from the ribs called uncinate processes.

The vertebral column of young birds clos
resembles that of reptiles; later in life it tak
on the characters which are the special pecu
arities of birds, and are found nowhere else.

We might enumerate other connecting lin
between the two groups; but enough has pr
bably been detailed to serve the purpose of th
chapter, which was to show that birds and re
tiles are closely akin, however much they m
appear on the surface to differ.

In the previous chapter we followed t
gradual unfolding and development of t
various groups of birds, starting with arch
opteryx, and discussed, as nearly as we cou
guess, the ancestral forms of each. In t
present we have endeavoured to pierce the ve
of thick darkness that enshrouds the birth
the earliest bird-like forms. A certain measu
of success has attended this attempt, it must b
admitted; but much yet remains to be do
before we are in possession of sufficient eviden
to speak with that certainty which will mak
converts of the most sceptical.

The most that we can say at present is th
the "Founder of the House" was of a reptilia
nature, and probably sprang from the same sto
as that which ended in the gigantic dinosau
long since extinct. Possibly from this sam
stock came the flying pterodactyle. In th
way we could account for certain strong poin
of resemblance between the skull of this ancie
lizard and that of the bird.

Our "Story" is now told. We hope that ose who have followed it carefully will close is little book with a feeling of satisfaction.

In conclusion we would remark that it may em to many that the bird's wing has come ry prominently and frequently to the front these pages. This is as it should be. It is ie standard by which we can best measure the te of progress or decay, which a species, or a ce, as the case may be, has undergone. From ie tip of its beak to the tip of its tail, a bird is ssentially a flying animal. Whatever progress has made in development, has been in the first stance to this end. Whatever evidence of ecay any given form may bear witness to, is raceable to the loss of flight, the greatest of its ossessions: and the date of its fall is approxiately to be gauged by the amount of degenera-on which the wing has undergone. It is the ulse of its life-history.

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